KONGSBERG

Seapath® 320

Installation Manual

About this document

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Rev. 1	2010-02-24	FOS		FOS
	First issue of this manual			
Rev. 2	2010-06-25	FOS		FOS
	Description of serial port extender and minor changes in the text			

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Abbreviations

AP	Aft Perpendicular. The vertical intersection of the design waterline at the stern, alternatively the centerline of the rudder stock.
BL	Base Line. Is the same as the keel for a vessel with horizontal keel line.
CEP	Circular Error Probability
CG	Centre of gravity. The mass centre of a vessel. This is normally the location with least linear acceleration, and hence the best location for measurements of roll and pitch.
CL	Centre Line. Is the longitudinal axis along the center of the ship.
DGLONASS	Differential GLONASS
DGNSS	Differential Global Navigation Satellite System
DGPS	Differential GPS
ED50	European Datum of 1950
EGNOS	European Geostationary Navigation Overlay System (SBAS-Europa)
EPE	Estimated Position Error
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPS Time	The time in the GPS system. The GPS time is within UTC time ±180 nsec (95 per cent) plus leap second.
GUI	Graphical User Interface
HMI	Human Machine Interface
HP	High Precision
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organization
IMU	Inertial Measurement Unit
LGND	Logic Ground
MP	Monitoring Point

MRU 5	Motion Reference Unit, model 5. This is the IMU within the Seapath measuring dynamic linear motion and attitude. A MRU consists of gyros and accelerometers.
NMEA	National Marine Electronics Association. NMEA 0183 is a standard for interchange of information between navigation equipment.
NRP	Navigation Reference Point. The reference point for all measurements in Seapath. The recommended used NR is the vessel CG or rotation center.
PGND	Power Ground
PPS	One Pulse Per Second
PRN	Pseudorandom Noise
RMS	Root Mean Square
RTCM	Radio Technical Commission of Maritime Services
SL	Speed Along Ship
SNR	Signal/Noise Ratio
SOG	Speed Over Ground
SBAS	Satellite Based Augmentation System
SRRD	Seatex Rescue and Restore Disk
ST	Speed Transverse Ship
SW	Software
UTC	Universal Time Co-ordinated. This is the official time in the world and has replaced GMT (Greenwich Mean Time) as the official time.
UTM	Universal Transverse Mercator
WAAS	Wide Area Augmentation System (SBAS-USA/Canada)
WEEE	Waste Electrical and Electronic Equipment
WGS84	World Geodetic System of 1984

Terminology

Alignment	Is the process of adjusting the current internal navigation frame in the instrument to the true external frame.
Antenna bracket	Is the arrangement for mounting the GPS antennas
Antenna holder	Is the arrangement on board the vessel for mounting the antenna bracket to.
Attitude	The orientation relative to the vertical axis of a vehicle. Heading is not included. If heading is included, the word "orientation" is used for the vehicle.
Beam	The maximum width of the vessel at Main Deck level (B. mld)
Heading	The direction of the main axis (bow direction) of the vehicle as opposed to course, which is the direction of motion of the vehicle. Yaw angle as defined here is the same as heading.
Heave	The vertical dynamic motion of a vehicle and defined positive down. Heave position and velocity are dynamic motion variables oscillation around a mean value, typically zero.
Height	The height in the Seapath product is defined as the vertical position relative to the WGS84 datum (rotational ellipsoid).
Host system	In this manual defined as Navigation computers, Dynamic Positioning Systems, etc., receiving data from Seapath.
Origin	The zero point in the coordinate system. The origin is the intersection point between AP, BL and CL.
P-axis	This axis is fixed in the vehicle, and points in the starboard direction horizontally when the roll angle is zero. Positive rotation about this axis is bow of the vehicle up.
Pitch	A rotation about the pitch axis is positive when the bow moves up. Normally, pitch means the dynamic pitch angle motions.
R-axis	This axis is fixed in the vehicle, and points in the forward direction horizontally when the pitch angle is zero. Positive rotation about this axis is starboard side of the vehicle down.
Roll	A rotation about the roll axis is positive when starboard side of the vehicle moves down. Normally, roll means the dynamic roll angle motion.
Starboard	When looking in the bow direction of a vehicle, this is the right hand side of the vehicle.
Surge	The alongship dynamic motion of a vehicle and defined positive forward.

Sway	The athwartship dynamic motion of a vehicle and defined positive starboard.
Y-axis	This axis is fixed in the vehicle and points in the downward direction when the vehicle is aligned horizontally. Positive rotation about this axis is turning the bow of the vehicle to starboard.
Yaw	A rotation about the vertical axis is positive when turning Eastward (Clockwise) when the vehicle cruises in North direction. Normally, yaw means the dynamic yaw motion.

References

[1] M300-52, User Manual, Seapath 320

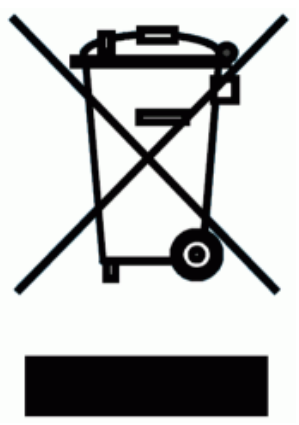
[2] NMEA 0183 Standard for Interfacing Marine Electronic Devices, Version 3.0

[3] RTCM Recommended Standards for Differential Navstar GPS/GLONASS services, Version 2.3

[4] *GPS-702GG and GPS-701GG User Guide,* OM20000095 Rev 1, NovAtel Inc. January 23, 2006

Health, environment and safety warnings

All electrical and electronic components have to be disposed of separately from the municipal waste stream via designated collection facilities appointed by the government or local authorities. The correct disposal and separate collection of your old appliance will help prevent potential negative consequences for the environment and human health. It is a precondition for reuse and recycling of used electrical and electronic equipment. For more detailed information about disposal of your old appliance, please contact your local authorities or waste disposal service.



Until further notice is given regarding reuse, disassembly or disposal, the equipment at end-of-life, could be returned to Kongsberg Seatex AS if there is no local WEEE collection.

The equipment is marked with this pictogram.

Restrictions in export

Export of the MRU 5 component within the Seapath product to other countries than EU countries or Argentina, Australia, Canada, Iceland, Japan, New Zealand, Switzerland, South-Korea, Turkey, Ukraine and USA, requires an export license.

Notice to Importer: The MRU product specified in this document has been shipped from Norway in accordance with The Ministry of Foreign Affairs' Official Notification on Export Control and may be subject to restrictions if re-exported from your country.

Restrictions in guarantee

The liability of Kongsberg Seatex is limited to repair of the Seapath system only under the given terms and conditions stated in the sales documents. Consequential damages such as customer's loss of profit or damage to other systems traceable back to Seapath malfunction are excluded. The warranty does not cover malfunctions of the Seapath resulting from the following conditions:

1 The MRU is not shipped in the original transport box.

2 The MRU has been exposed to extreme shock and vibrations.

3 The MRU housing has been opened by the customer in an attempt to carry out repair work.

4 Over-voltage or incorrect power connection.

5 Shorting of GNSS antenna cable during operation of the Seapath systems.

Restrictions in use

The Seapath function is based on GNSS signals and requires free sight to the sky, minimum four visible satellites, PDOP value less than 6 and otherwise normal conditions to operate. It is designed for use on board marine surface operated vehicles with linear acceleration less than ±30 m/s^2 (±3g) and an angular rate range less than ±150°/s.

Only relative dynamic heave position is calculated.

1 PRODUCT DESCRIPTION

This manual describes a typical survey installation of the Seapath 320 system on a vessel. For all other information about the Seapath, please consult the *User Manual*, reference [1].

1.1 Purpose and application

Seapath 320 combines the latest achievements in advanced GPS and GLONASS technology aided by a high performance IMU (Inertial Measurement Unit). The integration of GPS/GLONASS and an IMU is ideal due to the combination of complementary physical qualities into a tightly integrated solution.

1.2 System components

The system is supplied with the following parts:

- Seapath 320 Processing Unit including processing software. Part no. M300-23.
- Antenna Bracket in aluminium, 2.5-metre baseline. Part no. M320-21.
- Antennas, two GPS/GLONASS L1&L2 antennas. Part no. G060-24N.
- Cable, Interconnection, N-M/N-F, four of 1 m. Part no. G071-91. Two as adapter cable from GNSS antenna connector to cable and two as adapter cable for GNSS antenna cable to PU (N to N).
- Seapath HMI Unit with operator software. Part no. M300-04.
- Cable for power, Processing and HMI Unit, two of 2.5 m. Part no. G032-28.
- Monitor, 17" standard LCD, table mount. Part no. G060-32.
- Keyboard (US layout). Part no. G062-11.
- PC mouse. Part no. G062-16.
- MRU 5 sensor. Part no. MRU-5.
- MRU wall mounting bracket. Part no. MRU-M-MB3.
- MRU junction box for flexible connection of MRU to Seapath. Part no. MRU-E-JB1.
- Cable, heavy duty screened cable with 14 twisted pairs. Part no. MRU-E-CS1.
- MRU transportation box. Part no. MRU-M-SC1.
- Seapath 320 Product Manuals. Part no. M300-72.

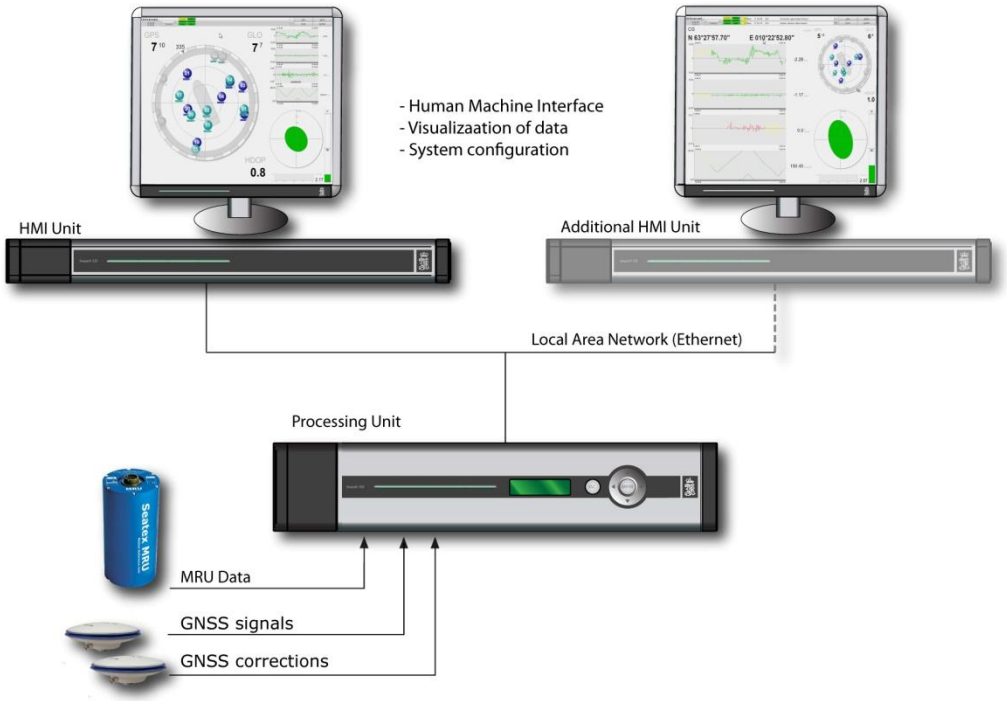


Figure 1 Standard system for 19-inch rack mounting

In addition to the above delivered parts, the following is needed:

- A 19-inch rack for mounting of the Processing Unit.
- A 19-inch rack for mounting of the HMI Unit.
- GNSS antenna cables and the cable between the Processing Unit and the MRU junction box.
- DGPS/DGLONASS corrections on one or more serial lines for improved position accuracy (recommended).
- Additional cables for input of DGPS/DGLONASS corrections, and for output lines to external equipment.
- Devices for reference measurements of roll, pitch and heading (for calibration).

General arrangement drawings of the ship should be acquired to simplify determination of offsets between the GNSS antennas, the MRU, the Navigation Reference Point (NRP) and the different monitoring points. Locations for the various parts of the system must be decided and mounting arrangement for the Antenna Bracket and sufficient lengths of cable made available.

An external heading reference, for example a surveyed quay, is required for heading calibration. Survey equipment should be made available for determination of the alignment offset in roll, pitch and yaw.

The MRU unit is shipped in a specially designed transportation container. Keep the MRU in this container until ready to install the unit in the mounting bracket.

Note *After the installation, please save the transportation container. To maintain warranty validity, the MRU must be shipped in this container for service or repair.*

2 TECHNICAL SPECIFICATIONS

2.1 Performance data

Roll and pitch accuracy for ±5° amplitude ..... 0.02° RMS (*)

Heading accuracy with 2.5 metre antenna baseline ..... 0.075° RMS

Heading accuracy with 4 metre antenna baseline ..... 0.05° RMS

Scale factor error in roll, pitch and heading ..... 0.08 % RMS

Heave accuracy (real-time output) ..... 5 cm or 5 % whichever is highest

Heave motion periods (real-time output) ..... 0 to 20 seconds

Heave accuracy (delayed signal, PFreeHeave™) ..... 3 cm or 3 % whichever is highest

Heave motion periods (delayed signal, PFreeHeave®) ..... 0 to 50 seconds

Position accuracy with DGPS/GLONASS ..... 0.5 m RMS or 1 m 95 % CEP

Position accuracy with SBAS ..... 0.5 m RMS or 1 m 95 % CEP

Position accuracy with RTK (floating ambiguity mode) .....
..... 0.15 m RMS or 0.35 m 95 % CEP

Velocity accuracy ..... 0.03 m/s RMS or 0.07 m/s 95 % CEP

The performance figures are valid with a minimum of four visible satellites, HDOP less than 2.5, PDOP less than 6, high quality DGPS corrections, correctly measured offsets and otherwise normal conditions. Excessive multipath, GNSS signal obstructions or interference may reduce the performance.

2.2 Physical dimensions

2.2.1 Processing Unit

Height ..... 88.1 mm (2U)

Width ..... 485 mm (19")

Depth ..... Min 325 mm (excluding connectors on rear panel) and max 412 mm

Weight ..... 5.4 kg

Colour ..... Front anodized natural

2.2.2 HMI Unit

Height ..... 43.65 mm (1U)

Width ..... 485 mm (19")

Depth ..... Min 325 mm (excluding connectors on rear panel) and max 405 mm
Weight .....3.8 kg
Colour ..... Front anodized natural

2.2.3 Monitor, 17-inch LCD

Type .....Samsung SyncMaster 710n
Width ..... 380 mm
Height ..... 383 mm
Depth ..... 170 mm
Weight .....3.8 kg
Colour .....Black and silver

2.2.4 MRU Unit

Type .....MRU 5
Height ..... 204 mm (8.032")
Diameter ..... 105 mm (4.134")
Weight .....2.5 kg
Colour ..... Blue
Connector .....Souriau 851-36RG 16-26S50 (MIL. spec.)

2.2.5 MRU Wall Mounting Bracket

Type MRU-M-MB3
Length..... 265 mm
Width ..... 119 mm
Height ..... 119 mm
Weight .....1.6 kg
Colour ..... Black
Material.....POM-H

2.2.6 MRU Junction Box

Type MRU-E-JB1
Length..... 226 mm
Width ..... 126 mm
Height ..... 90 mm

Weight ..... 2.0 kg
Colour ..... Black
Material ..... Aluminium
Enclosure protection IP-65

2.2.7 Antenna Bracket

Type M320-21
Length ..... 2560 mm
Width ..... 75 mm
Height ..... 40 mm
Weight ..... 6.6 kg
Colour ..... Grey RAL 7035

2.2.8 GNSS antenna

Type ..... Novatel GPS-702-GG
Height ..... 69.1 mm
Diameter ..... 185 mm
Weight ..... 0.5 kg
Colour ..... White

The GNSS antenna is a right-hand circular polarised L-band antenna with an integral low-noise amplifier. The internal thread is $^{5}/_{8}$ x 11 (standard marine mount).

2.2.9 Cabinet

Height ..... 390 mm
Depth ..... 600 mm
Width ..... 553 mm
Depth with keyboard extended ..... 770 mm
Recommended free space from wall ..... 20 mm

2.3 Power

2.3.1 Processing Unit

Voltage ..... 100 - 240 V AC, 50/60 Hz

Power consumption ..... Max. 75 W[1]
Batteries ..... None, connection to UPS recommended

2.3.2 HMI Unit

Voltage ..... 100 - 240 V AC, 50/60 Hz
Power consumption ..... Max. 40 W
Batteries ..... None, connection to UPS recommended

2.3.3 Monitor, 17-inch LCD

Voltage ..... 100 to 240 V AC, 50/60 Hz
Power consumption ..... 23 Watts (typical)

2.3.4 MRU

Voltage ..... 24 V DC, from Processing Unit

2.3.5 GNSS antenna

Voltage ..... 5 V DC, from Processing Unit

2.4 Environmental

2.4.1 Processing Unit

Enclosure material ..... Aluminium
Operating temperature range ..... -15 °C to +55 °C[2]
Recommended operating temperature ..... Room temperature (+20 °C)
Storage temperature ..... -20 °C to +70 °C
Operating humidity ..... Max. 95 % non-condensing
Storage humidity ..... Less than 55 %
Ingress protection front ..... IP 42
Ingress protection rear ..... IP 21

[1] With MRU connected.
[2] Operating temperature up to +55 ºC for 10 hours.

2.4.2 HMI Unit

Enclosure material ..... Aluminium
Operating temperature range ..... -15 °C to +55 °C[3]
Recommended operating temperature .....Room temperature (+20 °C)
Storage temperature ..... -20 °C to +70 °C
Operating humidity ..... Max. 95 % non-condensing
Storage humidity ..... Less than 55 %
Ingress protection front..... IP 42
Ingress protection rear ..... IP 21

2.4.3 Monitor, 17-inch LCD

Operating temperature range ..... 5 to +40 °C
Relative humidity ..... 20 to 80 %

2.4.4 MRU Unit

Enclosure material ..... Anodised aluminium
Enclosure protection IP-66
Operating temperature range .....-5 to +55 °C
Operating humidity (max) ..... Sealed, no limit
Storage temperature range .....-20 to +70 °C
Storage humidity ..... Sealed, no limit
Max allowed vibration operational (10 – 2000 Hz continuous).....0.5 m/s^2
Max allowed vibration non-operational (0 – 200 Hz continuous).....20 m/s^2
Max shock non-operational (10 ms peak) .....1000 m/s^2

2.4.5 GNSS antenna

Operating temperature range ..... -40 °C to +85 °C
Ingress protection ..... IP X6 and IP X7

[3] Operating temperature up to +55 ºC for 10 hours.

2.5 External interfaces

2.5.1 Processing Unit

Serial ports.....6 non-dedicated isolated ports, RS-232 or RS-422
.....Isolated Com1 and Com2, 9 pin DSub, RS-232 or RS-422
Baud rate.....Up to 115 200 bytes/sec
LAN.....4 Ethernet ports
USB .....3 ports, 1 in front and 2 in rear
Data output rate .....Up to 200 Hz
Timing accuracy .....1 ms
Data delay..... All data in real-time (0 ms) plus transmission delay
1PPS signal accuracy.....220 nsec
Analog outputs.....3 user configurable channels, ±10 Volts

2.5.2 HMI Unit

USB .....3 ports, 1 in front and 2 in rear
LAN..... 1 Ethernet port in rear

2.5.3 MRU Unit

Serial ports.....1 RS-232 or RS-422
Digital output variables ..... Max. 16
Data output rates.....Max. 100 Hz
Timing .....< 1 ms

2.6 Product safety

2.6.1 Processing Unit

Electrical safety .....IEC 60950-1/EN60950-1
Electromagnetic compatibility (immunity/radiation).....IEC 60945/EN60945
Vibration.....IEC 60945/EN60945

2.7 Radio frequencies

2.7.1 GNSS antenna

L1 ..... 1588.5 ± 23.0 MHz

L2 ..... 1236.0 ± 18.3 MHz

LNA gain (typical) ..... 27 dB

2.7.2 GNSS receiver

GPS L1 ..... 1575.42 MHz

Glonass L1 .....1602.0 MHz for Fk=0 where k=(-7 to +13) channel spacing 562.5kHz

2.8 Data outputs

2.8.1 Processing Unit

Message format .....NMEA 0183 v. 3.0 of type:

- ZDA, GGA, GLL, VTG, HDT, GST, GSA and GRS
- NMEA proprietary PSXN, 20, PSXN, 21, PSXN, 22 and PSXN, 23

..... Simrad EM1000 (Simrad EM950 and EM1000 compatible)

..... Seapath binary format 3

..... Simrad EM3000 (Simrad EM3000, EM300 and HiPap compatible)

..... Calibration format

..... Echo sounder format

.....RD Instrument ADCP proprietary NMEA format, "PRDID"

..... Seapath binary format 11

..... Lehmkuhl gyro repeater format

..... 1PPS time tag, NMEA ZDA message

..... 1PPS time tag, Trimble compatible messages

.....Atlas Fansweep format

..... Echo sounder format 18, TSS1

.....RTCM v3, raw GPS output

..... Seapath binary format 23

..... PFreeHeave format

2.9 Data inputs

2.9.1 Processing Unit

DGPS corrections ..... RTCM-SC104 v. 2.2 and 2.3
..... Trimble CMR
DGLONASS corrections ..... RTCM-SC104 v. 2.2
Gyro compass ..... NMEA 0183 HEHDT and HEHRC
..... Robertson LR22 BCD format

2.10 Compass safe distance

2.10.1 Processing Unit

Standard compass (mounted in 6U cabinet) ..... 2.6 m

Note *If the Processing Unit is not marked with a compass safe distance label, the unit shall be placed five metres from both the steering compass and the standard compass.*

2.11 Cables

2.11.1 MRU cable

Type MRU-E-CS1
..... Heavy duty screened, 14 x 2 x 0.25 mm^2
Length ..... 3 m
Diameter ..... 13.5 mm
Weight ..... 0.27 kg/m
Flame retardation ..... IEC 332-1
Insulation ..... ETFE
Screen ..... Cu-braid

2.11.2 Processing Unit to MRU Junction Box cable

Type ..... LAMAC, 4 x 2 x 0.5 mm^2
Maximum length ..... 100 m
Diameter ..... 10 mm

Flame retardation.....IEC 332-3/A

2.11.3 GNSS antenna cables (Coax)

Type..... ½"-Superflex 50 BHF

Attenuation .....14 dB/100 m (at 1.6 GHz)

Maximum length (each cable).....100 m

Diameter ..... 13.2 mm

Minimum bend radius..... 32 mm

Flame retardation.....CATV, UL1581, IEC 332-3, IEEE383

Coax connectors ..... Huber+Suhner 11 N-50-9-9

If the antenna cables are not delivered by Kongsberg Seatex, make sure that the cables meet the following electrical specifications:

Insertion loss (max.)	15 dB (at 1.6 GHz)
Characteristic impedance	50 Ohm (nominal)
DC resistance (max.)	0.5 Ohm ground braid and centre conductor

Table 1 GNSS antenna cable specification

The antenna connectors on the Processing Unit are of N-type male. On the GNSS antennas both TNC-type female and N-type female are available. Optionally, an interconnection cable for transfer of connector type from TNC on the antenna to N-type on the antenna cable, can be delivered.

2.12 Interfaces Processing Unit

The rear panel of the Processing Unit contains communication interface ports for interfacing to external equipment. In addition, a USB and a LAN port are situated at the front together with the power switch.

Figure 2 Rear panel of Processing Unit without chord anchorage

Connector	**Type**	**Connected to**
GNSS 1	N connector 50 Ohm female	GNSS antenna
GNSS 2	N connector 50 Ohm female	GNSS antanna
IALA	N connector 50 Ohm female	Not in use
LAN 2	RJ-45	User configurable
USB 2	USB	User configurable
USB 3	USB	User configurable
LAN 3	RJ-45	Not in use
LAN 4	RJ-45	User configurable
Mouse	PS/2	Mouse
Keyboard	PS/2	Keyboard
COM 1	9 pin DSub male, RS-232	User configurable
COM 2	9 pin DSub male, RS-232	User configurable
VGA	HD15 female	Monitor
COM 9	5 pins terminal, RS-232/422	User configurable
COM 10	5 pins terminal, RS-232/422	User configurable
COM 11	5 pins terminal, RS-232/422	User configurable
COM 12	5 pins terminal, RS-232/422	User configurable
COM 13	5 pins terminal, RS-232/422	User configurable
COM 14	5 pins terminal, RS-232/422	User configurable

Connector	Type	Connected to
ALARM	3 pins terminal, relay	External alarm system
MRU	10 pins terminal, RS-422	MRU5 or MRU5+
IMU	10 pins terminal	Not in use
1PPS	6 pins terminal	External equipment
ANALOG OUT	10 pins terminal	User configurable
ANALOG IN	6 pins terminal	Not in use
115/230VAC	Power	Input of 115/230VAC

Table 2 Connectors at rear of Processing Unit

Connector	Type	Connected to
LAN 1	RJ-45	User configurable
USB 1	USB	User configurable

Table 3 Connectors at front of Processing Unit

Note *All numbering of the pins on the terminals goes from left (no. 1) to right*

2.12.1 RS-422 A and B signal definition

According to the following standard the signal state definitions are:

- IEC 61162-1. The idle, marking, logical 1, OFF or stop bit states are defined by a negative voltage on line A with respect to line B. The active, spacing, logical 0, ON or start bit states are defined by a positive voltage on line A with respect to line B. It should be noted that the above A with respect to B levels are inverted from the voltage input/output requirements of standard UARTs and that many line drivers and receivers provide a logic inversion.

2.12.2 Pin layout

2.12.2.1 COM 1 and 2

Com 1 and Com 2 at the rear of the Processing Unit are 9-pin DSub male and have the following pin layout.

Pin no.	RS-232	Pin no.	RS-232
1	DCD1	6	DSR1
2	RXD1	7	RTS1
3	TXD1	8	CTS1
4	DTR1	9	RI1
5	GND		

Table 4 Pin layout of Com 1 and Com 2

Note *Com 1 and 2 are not as timing accuracte with regard to timing as Com 9 to 14 and are not recommended used for timing critical outputs.*

2.12.2.2 Connector board

The screw terminal pin layout on the connector board at the rear of the PU is described below.

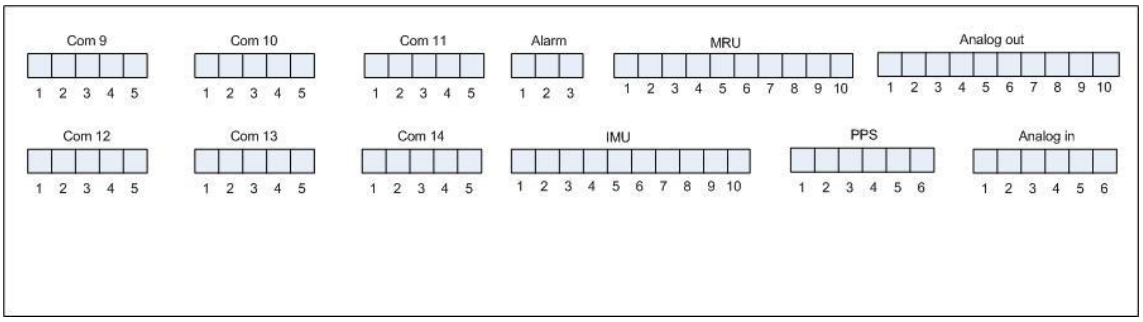


Figure 3 Connector board

Serial lines – Com 9 – Com 14

The system communicates with external equipment through the six RS-232 or RS-422 configurable serial input and output lines.

The configuration of serial lines and their default settings are:

Pin no.	Signal	
	RS-422	**RS-232**
1	RX_A	CTS
2	RX_B	RX
3	GND	GND
4	TX_A	RTS
5	TX_B	TX

Table 5 Pin layout of Com 9 through Com 14

PPS signal

A 1 pulse-per-second (1PPS) signal synchronized with GNSS time is available from the 6 pin terminal at the rear of the Processing Unit. This RS-422 1PPS signal originates from the GNSS receiver within the Processing Unit. The 1PPS signal is buffered and fed to the terminal. The 1PPS signal is active high and has a pulse width of 10 ms. The 1PPS is generated exactly once every second with its rising edge synchronised to GPS time.

Compared to the Seapath 200 models which have a BNC connector this Seapath model uses a serial signal. Pin no. 1 (TX_A) has a positive edge at the beginning of the pulse and pin no. 2 (TX_B) has a positive edge at the end of the pulse.

Pin no.	Signal	Direction
1	1PPS TX_A	Output
2	1 PPS TX_B	Output
3	GND isolated	Output
4	GND isolated	Input
5	1PPS RX_A	Input
6	1PPS RX_B	Input

Table 6 Pin layout of PPS port

Synchronized with this signal it is possible to output 1PPS time tag messages from Seapath. These messages are the 1PPS NMEA ZDA (format no. 13) or the Trimble compatible message (format no. 14).

→ *For description of the format for these messages, see APPENDIX A Output Protocols.*

Relay - alarm signal

The Processing Unit has a built-in alarm functionality and can be connected to an external alarm. An alarm will open the alarm relay, which can be used to trigger an external alarm. The external alarm can be connected to the Alarm 3 pin terminal.

Pin no.	Signal
1	NC
2	Alarm_Com
3	Alarm_NO

Table 7 Pin layout of Alarm

The diagram below shows how an external alarm can be connected to the Processing Unit ALARM terminal.

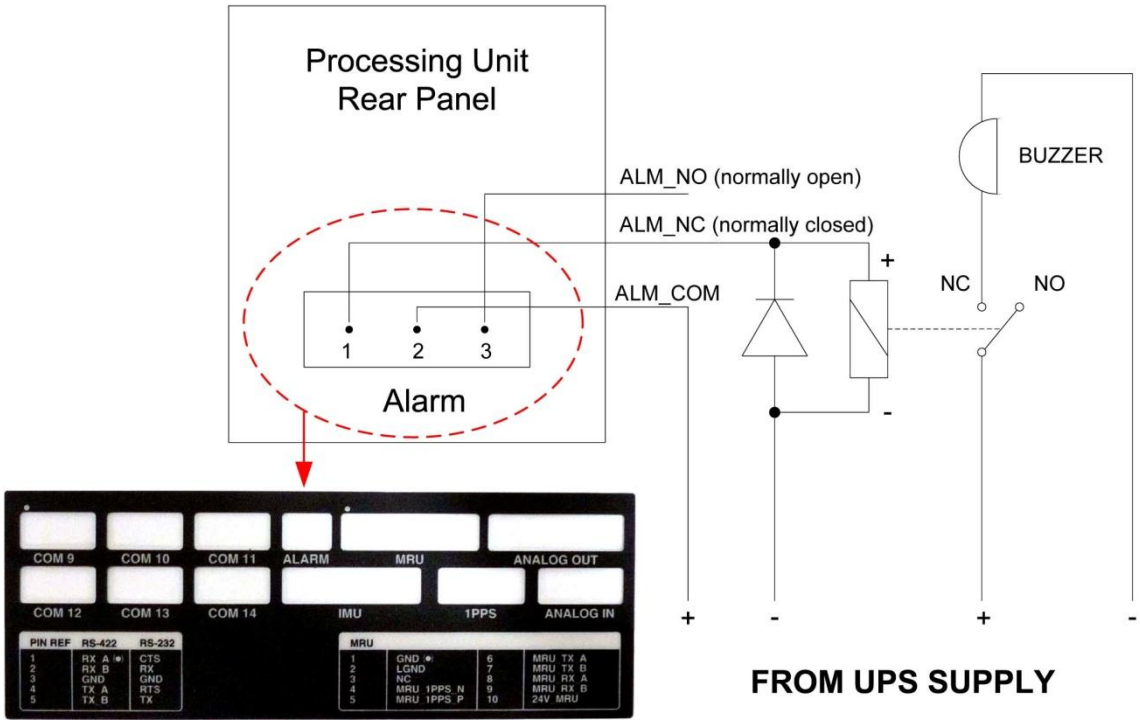


Figure 4 External alarm connection diagram

Analog output

Three analog output channels are available on the Analog Out 10 pin terminal. The variables available for analog output are roll, pitch, heave and Datawell Hippy compatible roll and pitch signals. The selection of variable and channel properties is performed in the operator software.

The pin wiring for the analog outputs is as follows:

Pin no.	Signal
1	GND_Isolated_DAC
2	Analog_Out_Ch2_N
3	Analog_Out_Ch2_P
4	GND_Isolated_DAC
5	Analog_Out_Ch1_N
6	Analog_Out_Ch1_P
7	GND_Isolated_DAC
8	Analog_Out_Ch0_N
9	Analog_Out_Ch0_P
10	GND_Isolated_DAC

Table 8 Pin layout of Analog Out

MRU

The MRU connector is used for power and interface to an MRU. Usually when an MRU is connected to a Processing Unit, a junction box is used to make the wiring easier.

The pin wiring for the MRU port is as follows:

Pin no.	Signal
1	GND
2	LGND
3	NC
4	MRU_1PPS_N
5	XIN/MRU_1PPS_P
6	TX_A
7	TX_B

Pin no.	Signal
8	RX_A
9	RX_B
10	24V_MRU

Table 9 Pin layout of MRU

IMU

The IMU terminal is not in use in this product.

Analog in

This terminal is not in use in this product.

Ethernet connection

The Processing Unit has the possibility to input and output data on individually configurable network ports. The format and update rate are configured for each port in the **NavEngine Configuration** view.

The Processing Unit has the following LAN and connection possibilities:

- **LAN 1 in the front**. This is primarily a service port and has less capacity (10/100 Mbps) that the other LANs. To connect this LAN to a network, a straight-through twisted pair (TP) cable with RJ-45 connectors must be used. A straight-through cable is one where the pins of one connector are connected to the same pins of the other connector. In special instances a crossover cable instead of a straight-through cable is needed, for example when connecting a Processing Unit to another Processing Unit. Below is the pin wiring for the different TP cables:

Straight-through			
Signal	**Pin no.**	**Pin no.**	**Signal**
TX+	1	1	TX+
TX-	2	2	TX-
RX+	3	3	RX+
RX-	6	6	RX-

Crossover			
Signal	**Pin no.**	**Pin no.**	**Signal**
TX+	1	3	RX+
TX-	2	6	RX-
RX+	3	1	TX+
RX-	6	2	TX-

Table 10 Pin layout for LAN 1 Ethernet ports

The pins 4, 5, 7 and 8 are not used.

- **LAN 2, 3 and 4 at the rear**. These LANs are of high capacity (10/100/1000 Mbps) and are of type auto crossover and auto negation. Below is the pin wiring for these LANs connected to different network capacities:

10/1000 or 100/1000 Mbps Ethernet		
Pin no.	**Signal**	**Description**
1	TX_DA-	Transceive data +
2	TX_DA-	Transceive data -
3	RX_DB+	Receive data +
4		
5		
6	RX_DB-	Receive data -
7		
8		

1000/1000 Mbps Ethernet		
Pin no.	**Signal**	**Description**
1	BI_DA+	Bi-directional pair +A
2	BI_DA-	Bi-directional pair -A
3	BI_DB+	Bi-directional pair +B
4	BI_DC+	Bi-directional pair +C
5	BI_DC-	Bi-directional pair -C
6	BI_DB-	Bi-directional pair -B
7	BI_DD+	Bi-directional pair +D
8	BI_DD-	Bi-directional pair -D

Table 11 Pin layout for LAN 2, 3 and 4 Ethernet ports

To connect the Processing Unit network, use twisted pair (TP) cable with RJ-45 connectors. To comply with the IEC 60945 standard shielded (screened) cable has to be used. Recommended cable type is CAT-5e. Category 5e cable is an enhanced version of Category 5 that adheres to more stringent standards. It is capable of transmitting data at speeds of up to 1000 Mbps (1 Gigabit per second). The maximum length of the cable that can be used is 100 metres (328 ft).

2.12.3 LED indicators Processing Unit

At the front of the Processing Unit there are four LED indicators. The LED to the left indicates power and software status, the second to the left indicates MRU status, while the LED to the right indicates network card status. The last LED has for the moment no function and will always be turned off.

Figure 5 Front panel of Processing Unit

The LED to the left indicates power and software status.

During start-up the indicator to the left appears red.

When the software is up and running, the indicator turns green.

The second LED to the left indicates MRU status.

The LED is red when there is no contact with the MRU.

The LED is yellow when there is contact with the MRU but PPS or data are missing.

The LED is green when there is contact with the MRU and PPS and data are OK.

The LED to the right indicates status of the four network cards.

The LED is red if there is an error on one or more network cards.

The LED is green when all four network cards are OK.

During normal operation, all LEDs should be green as indicated to the right.

2.12.4 MRU to Processing Unit cable wiring

The MRU is connected to the Processing Unit with a cable which is terminated in the MRU junction box in one end and with a 10 pin terminal for the Processing Unit in the other end. The MRU is then powered from the Processing Unit.

The cable wiring is as follows:

Processing Unit/MRU Pin no.	Signal	Pair no. Colour	MRU junction box Pin no.	MRU connector Pin no.
3	NC	Screen	chassis (x3 side)	
10	24V_MRU	1 white	1 (x1 side)	R
1	GND	1 blue	2 (x1 side)	B

Processing Unit/MRU Pin no.	Signal	Pair no. Colour	MRU junction box Pin no.	MRU connector Pin no.
9	RX_B	2 white	3 (x1 side)	C
8	RX_A	2 blue	4 (x1 side)	T
7	TX_B	3 white	5 (x1 side)	S
6	TX_A	3 blue	6 (x1 side)	P
5	XIN/MRU_1PPS_P	4 white	23 (x1 side)	U
2	LGND	4 blue	24 (x1 side)	a

Table 12 MRU to Processing Unit cable wiring

The MRU is supplied with 24 V DC power from the MRU port on the Processing Unit.

Note *The shield around each pair in the cable has to be individually isolated in the 10 pin terminal. The outer shield is connected to pin 8 (screen) in this terminal, which is an open end (not connected to earth). In the MRU junction box both the shield around each pair and the outer shield are terminated in pin 1 (chassis) on the x3 side.*

Note *It is important to insert a wire between pin 24 (LGND) and pin 27 (Shutoff) on the user side (x1) in the MRU junction box in order to establish RS-422 communication between the MRU and the Processing Unit. Otherwise there will be no communication between these two components.*

2.13 Interfaces HMI Unit

The rear panel of the HMI Unit contains communication interface ports for interfacing to the Processing Unit. In addition, a USB and a LAN port are situated at the front together with the power switch.

Connector	Type	Connected to
LAN	RJ-45	User configurable
USB 1	USB	User configurable
USB 2	USB	User configurable
Mouse	PS/2	Mouse

Connector	Type	Connected to
Keyboard	PS/2	Keyboard
VGA	HD15 female	Monitor
100 - 240 V AC	Power	Input of 100 - 240 V AC

Table 13 Connectors at rear of HMI Unit

Connector	Type	Connected to
USB	USB	User configurable

Table 14 Connectors at front of HMI Unit

2.13.1 Pin layout

2.13.1.1 Ethernet connection

The HMI Unit has one LAN port at the rear. This port is mainly used to connect the HMI Unit to the Processing Unit (normally LAN 2) via network. This LAN has 10/100 Mbps capacity.

To connect this LAN to a network, a straight-through twisted pair (TP) cable with RJ-45 connectors must be used. A straight-through cable is one where the pins of one connector are connected to the same pins of the other connector. Below is the pin wiring for the twisted pair (TP) cable:

Straight-through			
Signal	**Pin no.**	**Pin no.**	**Signal**
TX+	1	1	TX+
TX-	2	2	TX-
RX+	3	3	RX+
RX-	6	6	RX-

Table 15 Pin layout for HMI Unit Ethernet ports

The pins 4, 5, 7 and 8 are not used.

To connect the HMI Unit network, use twisted pair (TP) cable with RJ-45 connectors. To comply with the IEC 60945 standard, shielded (screened) cable has to be used. Recommended cable type is CAT-5e. Category 5e cable is an enhanced version of Category 5 that adheres to more stringent standards. It is capable of transmitting data at speeds of up to 1000 Mbps (1 Gigabit per second). The maximum length of the cable that can be used is 100 metres (328 ft).

2.13.2 LED indicators HMI Unit

At the front of the HMI Unit there are four LED indicators. The LED to the left indicates power and software status. The other LEDs have for the moment no function and will always be turned off.

During start-up the indicator to the left appears red.

When the software is up and running, the indicator turns green.

Figure 6 Front view of HMI Unit

3 INSTALLATION

This chapter covers installation of the Seapath 320 system. The installation includes:

- Location of the system parts (Processing Unit, HMI Unit, MRU, GNSS antennas)
- Mounting of the Seapath cabinet
- Mounting of the MRU bracket
- Installation of the coax connectors
- Mounting of the antenna bracket, GNSS antennas and cable
- Connection of cables between Seapath and external equipment
- System start

3.1 Logistics

Safety: General safety guidelines to be followed when working in mast and on deck.

Personnel qualifications: Trained electrical workers.

Minimum number of personnel: 2, especially when mounting the Antenna Bracket to the Holder.

Ship location: The GNSS antennas have to be mounted such that blocking of the GNSS signal is avoided. The MRU 5 unit is preferably mounted low in the ship or close to the system to be compensated. The Processing Unit can be mounted on the bridge or in the instrument room. The HMI Unit, the monitor is typically mounted on the bridge.

Special tools required: None.

3.2 Location of the system parts

The following sections contain instructions regarding mounting of the various system parts.

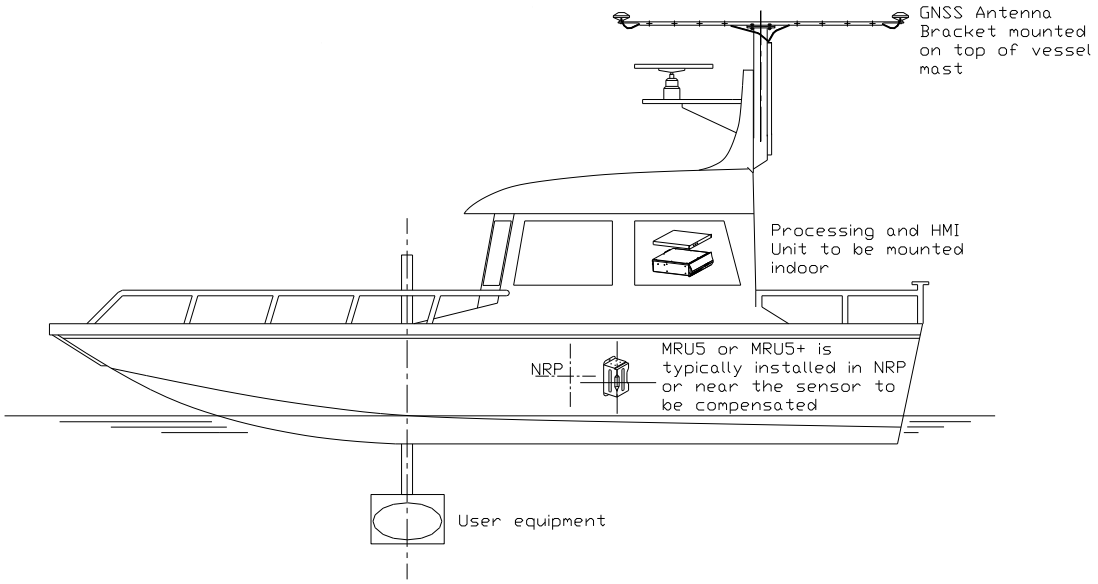


Figure 7 Location of system parts

3.2.1 GNSS antennas

For the GNSS antennas, consider the following:

- The space above the antennas has to be free of obstructions of any kind. The antenna should be protected from direct illumination of radar beams and other transmitting antennas such as Inmarsat antennas. Seapath is more sensitive to blocking and reflections (multipath) of GNSS signals than GNSS sensors which only utilise pseudo-range data. This since Seapath also utilises carrier phase measurements for heading determination, and both GNSS antennas need to see at least four common satellites at the same time.

Caution *The GNSS antennas have to be mounted in such a way that blocking of the GNSS signal I avoided.*

- In order to reduce problems due to multipath effects, the GNSS antennas have to be mounted above the nearest deck at a height which is equal to the width of this deck or higher.
- The Antenna Bracket has to be mounted in such a way that torsion movement relative to the ship's hull is kept at an absolute minimum.

Note *If the Antenna Bracket supplied by Kongsberg Seatex is not used, it is important that the antennas are rigidly mounted so that the distance between the antennas does not change due to vibrations or accidental dislocation.*

- The antenna baseline length is recommended in the range 2.5 to 4.0 metres, but 1 to 5 metres can be used. Maximum heading accuracy is achieved at 4.0 metres baseline.
- The maximum length for each of the antenna coaxial cables is 100 metres for the cable type normally delivered with the system (1/2" Superflex). If longer cables are needed, a low noise signal amplifier (LNA) should be fitted.

3.2.2 MRU 5

For the MRU, consider the following:

- The unit is designed for installation in an indoor environment and for operation within the temperature range.
- The unit is to be mounted close to the user equipment of which it is supposed to measure the motion. This is to avoid errors in alignment with the user equipment and to eliminate errors due to ship hull torsion.
- If the system is not allocated to measure motion of a particular user equipment, mount the MRU as close to the Navigation Reference Point (NRP) as possible. This to ensure best roll and pitch measurements. If it is not possible to mount the MRU close to NRP, try to mount it along the longitudinal axis of the ship and as close to the NRP as possible. Avoid mounting the MRU high up or out to the side of the ship.

Be aware of:

Vibrations Direct mounting onto the main hull structure is preferable.

Note *The worst mounting positions are thin walls that may come in resonance with vibrations driven by machinery, propellers, pumps or motors. Avoid mounting the MRU close to hydraulic pumps and valves where there are high frequency vibrations.*

Temperature changes For safe mounting of the MRU, place the unit in a location where the temperature is low and where changes in temperature are slow. A location directly on the hull far away from the heat of the machinery, heaters and air conditioning systems is preferable.

Corrosion problems Place the MRU in a location where no direct splashing seawater is present.

3.2.3 Processing Unit

When installing the Processing Unit, consider the following:

- The unit is designed for indoor installation and should not be exposed to heavy vibrations, transformers or similar.
- The unit should be resiliently mounted in a 19-inch rack to be in accordance with the environmental standard IEC60945/EN60945.
- The unit has an internal fan and requires free airflow from the rear and out to the sides. It is recommended that ventilation or air conditioning is provided in order to keep the ambient operating temperature around +20 °C. The best location is typically in the instrument room or on the bridge mounted into a 19-inch rack with good ventilation and resilient mounting.
- It is recommended that the area around the unit is kept free from dust and static electricity.
- All connections to the unit are on the rear side and available space for cable connections and service must be provided.

3.2.4 HMI Unit

When installing the HMI Unit, consider the following:

- The unit is designed for indoor installation and should not be exposed to heavy vibrations, transformers or similar.
- The unit should be resiliently mounted in a 19-inch rack to be in accordance with the environmental standard IEC60945/EN60945.
- The unit has an internal fan and requires free airflow from the rear and out to the sides. It is recommended that ventilation or air conditioning is provided in order to keep the ambient operating temperature around +20 °C. The best location is typically on the bridge mounted into a 19-inch rack with good ventilation and resilient mounting.
- It is recommended that the area around the unit is kept free from dust and static electricity.
- All connections to the unit are on the rear side and available space for cable connections and service must be provided.

3.2.5 Monitor

When installing the monitor, consider the following:

- The unit is designed for installation in an indoor environment and for operation within the temperature range. The best location is typically on a table in the instrument room or on the bridge mounted close to the HMI Unit.

- The HMI Unit and the monitor should be mounted close to each other to reduce the length of the VGA cable.
- It is recommended that the area around the unit is kept free from dust and static electricity.

3.3 Survey of sensors on vessels

All sensors need to be surveyed. The points to measure on the various sensors (MRU, GNSS antenna, gyro), and the accuracy requirements, depend on the function of the sensor.

If a sensor has a defined direction (fwd/stb/up), the direction in which it is mounted must be determined.

All available sensors can be surveyed either in dock or alongside.

3.3.1 Vessel reference system

All vessels must have a defined Cartesian coordinate system to which all sensors must be referenced. This system should be well described in both text and drawings to avoid common misunderstandings.

Such a coordinate system can consist of a Y-axis (positive forwards) which is parallel to the centre line of the vessel, an X-axis (positive to starboard) and a Z-axis (positive upwards). All axes are mutually perpendicular.

The origin, where Y=0, X=0 and Z=0 (CRP, or Common Reference Point), is normally defined to be at the AP (centre Rudder Stock, underside keel), which is also where the design origin is commonly located in GA drawings.

The reference plane of this system must be well defined and described. This can be a Best Fit Plane top main deck or a Best Fit Plane through the draught marks on the hull. This is particularly important on a floating vessel, as it is not possible to project the horizontal plane from land.

Note *If the CRP is to be located at the Centre of Gravity (COG), the load conditions used when defining the COG must be known, as the actual COG moves dynamically depending on load conditions of the vessel.*

3.3.2 MRU

The following is to be surveyed:

- Position (X,Y,Z) of sensor point (e.g. for an MRU 5 use centre top chassis)
- Mounting angles:
  - Yaw (heading)

- Pitch
- Roll

Pitch and Roll mounting angles should ideally be confirmed against MRU logs, for instance during Gyro calibration.

3.3.3 GNSS antennas

The following is to be surveyed:

- Position (X,Y,Z), centre of the antenna #1 disc (or otherwise defined sensor point).
- Angular offset between the line from centre antenna #1 to centre antenna #2 and the vessel centre line (CL).

Note *This offset should be confirmed against a Seapath GPS heading log, typically during gyro calibration.*

3.3.4 Gyro

If a gyro compass is interfaces to the Seapath system, the following is to be surveyed:

- The offset between the gyro compass heading and the vessel centre line (CL).

Note *The heading offset to be surveyed to an accuracy better than 1°.*

Static gyro calibration/verification (heading log) and DGNSS health check should be done after all DGNSS and gyro systems are installed and fully operational. This can be performed in dock or alongside.

Dynamic gyro calibration/verification and attitude control (heading, roll, pitch control) must be performed at sea.

3.3.5 Survey accuracy

The Seapath 320 product must be surveyed to the following accuracy level. If not, the performance of the product will be degraded.

- Lever arm vector from CRP to GNSS antenna position (X, Y, Z): < 0.1 metre.
- Lever arm vector from CRP to MRU (X, Y, Z): < 0.1 metre.
- MRU 5 misalignment angles (Roll, Pitch, Yaw) with the vessel axes: < 0.1°.

3.3.6 Cabinet mounting

3.3.6.1 Mounting Seapath with delivered cabinet

The cabinet should be securely mounted. Drilling plan for the resilient mountings is included in the attached drawings.

Caution *The cabinet must be connected to a grounded outlet.*

It is recommended that the cables attached to the rear of the unit should be long enough to accommodate all service from the front.

The cabinet must be mounted in such a way that the minimum cable bends (on the rear side) are not exceeded. For the antenna cables it may be necessary to use the short transition RG-213 or RG-214 cable in order to route the cables properly into the cabinet.

3.3.6.2 Mounting Seapath without delivered cabinet

A system delivered without a cabinet shall be mounted on attachment rails in a standard 19-inch rack. Minimum depth of the rack is 500 mm. It is recommended that the rack is resiliently mounted.

It is recommended that the rack has air inlet on top and bottom or ventilation splits on the sides. The Processing and HMI units have ventilation on the sides. Forced ventilation may be required if the cabinet contains several electronic modules.

All cables connected to the unit must be screened. Make sure that the minimum antenna cable bends are not exceeded.

Note *The recommended keyboard cable length is 3.3 m (10 feet) maximum without degradation. If longer keyboard cable is needed, please use keyboard extender.*

3.4 Installation procedures

3.4.1 Mechanical installation

The mechanical installation consists of:

- Making a holder for the Antenna Bracket and having it fastened in a suitable location in a mast.
- Mounting the Antenna Bracket with the GNSS antennas on a holder in the mast.
- Mounting the MRU bracket and the MRU near the user equipment for which attitude data is wanted, or close to the selected Navigation Reference point.

- Mounting of the Processing Unit in a rack in the instrument room or bridge.
- Mounting of the HMI Unit in a rack in the instrument room or bridge.
- Mounting the monitor close to the HMI Unit.

The installation procedure described below assumes that the Antenna Bracket delivered by Kongsberg Seatex is used and that a holder for this Antenna Bracket is prepared in accordance with the antenna holder drawing in chapter 5.

3.4.1.1 GNSS antennas

The mechanical installation of the various parts is performed in the following steps:

1 First the user has to make a holder for the Antenna Bracket (the holder is not part of the Seapath delivery) and have it properly fastened to the mast in the preferred orientation (horizontal or vertical). When the Antenna Bracket is mounted vertically, the drawings in Figure 8, Figure 9 and Figure 10 are not correct.

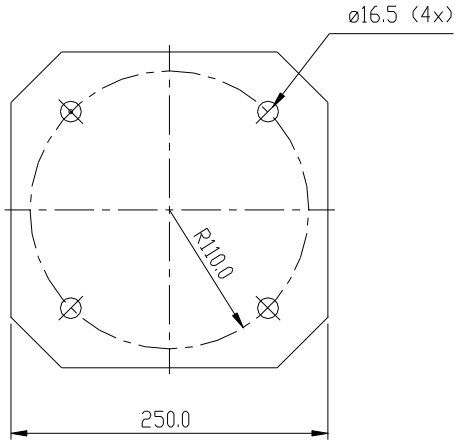


Figure 8 Dimensional drawing for antenna holder

2 Bring the Antenna Bracket, the two GNSS antennas and the antenna cables as close as possible to the location of the antenna holder. While both the GNSS antennas and the Antenna Bracket are down on deck, mount the GNSS antennas on the Bracket with both antennas oriented in the same direction. Depending on antenna type, labelling on the antenna housing (arrow or text) or connector location is used to determine direction. Figure 9 shows the antennas oriented with connectors pointing in the same direction. The antennas are not marked, and are interchangeable but called no. 1 or 2 for reference. The normal orientation of the Antenna Bracket is along ship with antenna no. 1 aft. It can, however, be mounted in any orientation, provided it is approximately horizontal.

Note *Both GNSS antennas have to be mounted on the Bracket oriented in the same direction, otherwise the system will have degraded heading performance.*

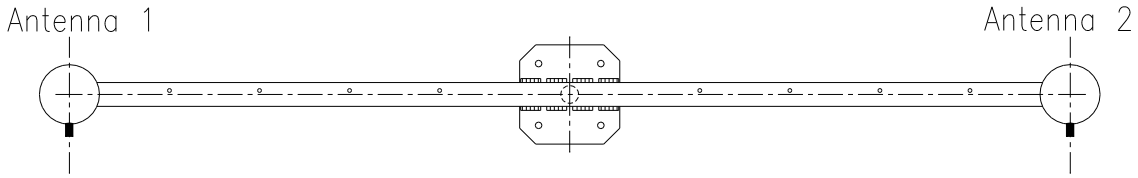


Figure 9 Top view of Antenna Bracket

3 The screws for mounting the GNSS antennas to the Bracket must be secured with washers.

4 Connect the antenna cables to both GNSS antennas. The connection between the antenna and the antenna cable should be sealed against water penetration, preferably by using waterproof self-vulcanising tape. The GNSS antenna cables are then strapped inside the Antenna Bracket as shown in Figure 11.

5 Lift the Antenna Bracket in the preferred direction on the holder.

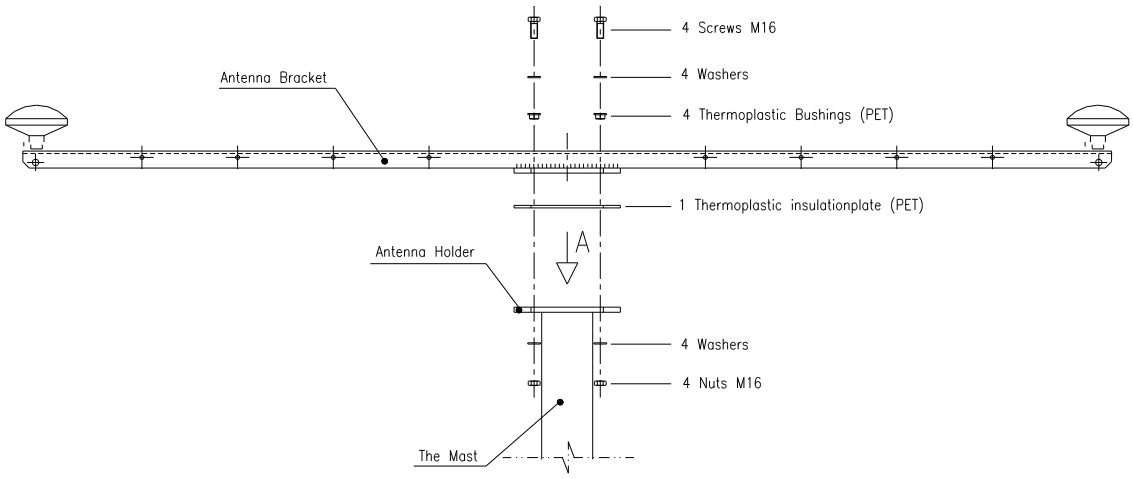


Figure 10 Different components for mounting of Antenna Bracket

6 Ensure that the delivered insulation plate is used between the Antenna Bracket and the holder, and that the four bushings are placed in the mounting holes before the screws are entered. The nuts should be secured with washers or by utilising self-locking nuts.

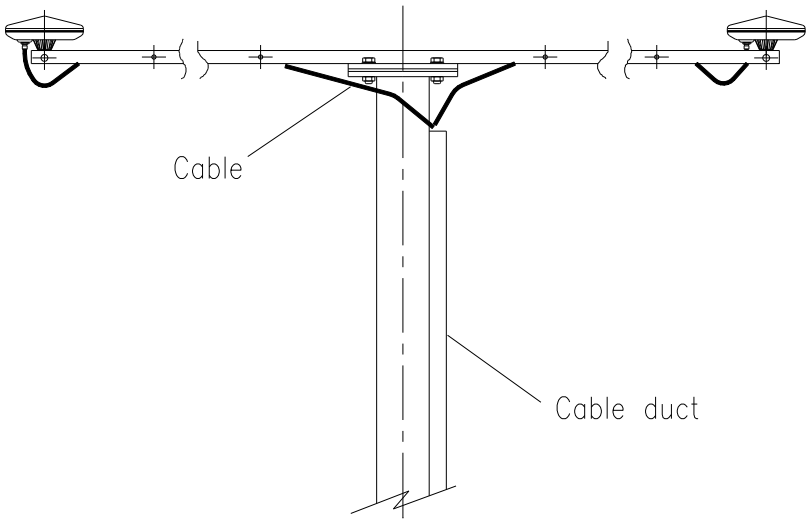


Figure 11 Side view of GNSS antenna installation

3.4.1.2 MRU, Processing and HMI Unit

The mechanical installation consists of:

- Mounting the MRU bracket and the MRU near the user equipment for which attitude data is wanted, or close to the selected Navigation Reference point.
- Mounting of the Processing Unit in a rack in the instrument room or bridge.
- Mounting of the HMI Unit in a rack in the instrument room or bridge.

The mechanical installation of the various parts is performed in the following steps:

1 When the best mounting location for the MRU has been identified, place the MRU mounting bracket in the preferred orientation and make screw holes in the foundation. If the orientation of the bracket can be freely selected, mount the bracket on the longitudinal or transversal bulkheads of the ship with the opening pointing downward, as shown in Figure 12. This will ensure easy and accurate orientation of the MRU according to the longitudinal axis. Reserve sufficient space below the bracket to allow insertion of the MRU from below.

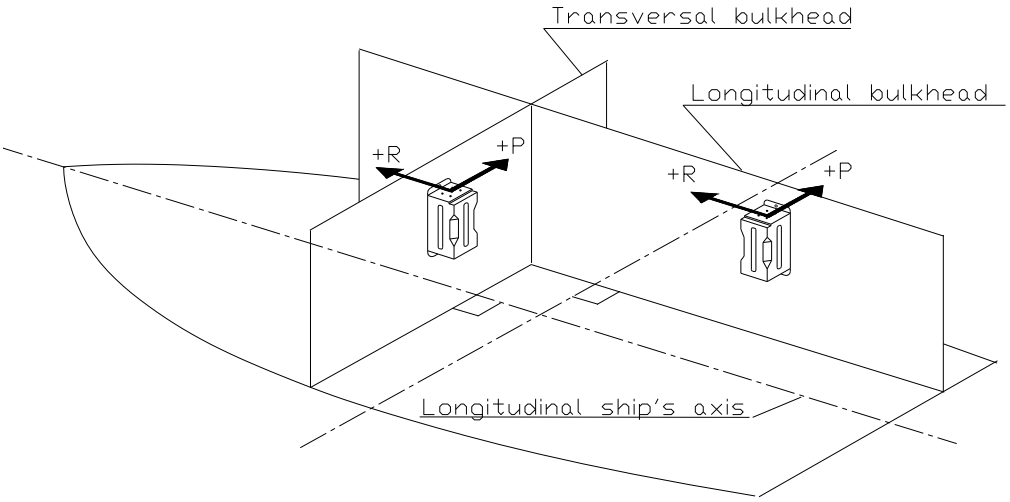


Figure 12 Recommended orientation of the MRU mounting bracket

2 Mount the MRU bracket on the wall, preferably with the opening pointing down, as shown in Figure 13. Mark and drill a M6 hole for the top screw (1) and enter the screw without tightening it completely. Align the bracket vertically using its own weight or by aligning it in relation to the wall. Drill two holes for the lower screws (2) and insert and securely tighten all three screws, using washers or self-locking nuts.

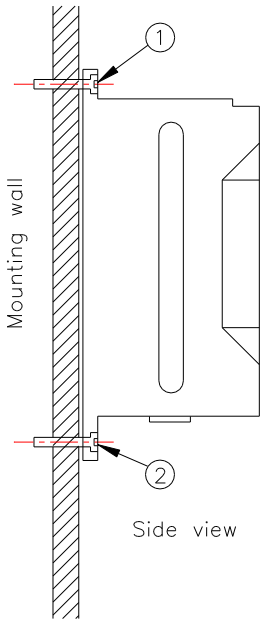


Figure 13 Wall mounting of bracket with MRU connector pointing down

3 Insert the MRU into the bracket. In order to achieve the orientation as shown in Figure 12, the MRU must be rotated in the bracket. Apply Loctite 242 glue or equivalent on the four MRU screws (3).

Note *The MRU R+ arrow must always point in the bow direction unless the default mounting orientation of the unit is modified in the MRU configuration*

4 Apply the sticker (4) onto the bracket according to the actual mounting direction of the MRU, as shown in Figure 14. In this way, the actual mounting direction is identified in case the unit is to be exchanged or removed temporarily.

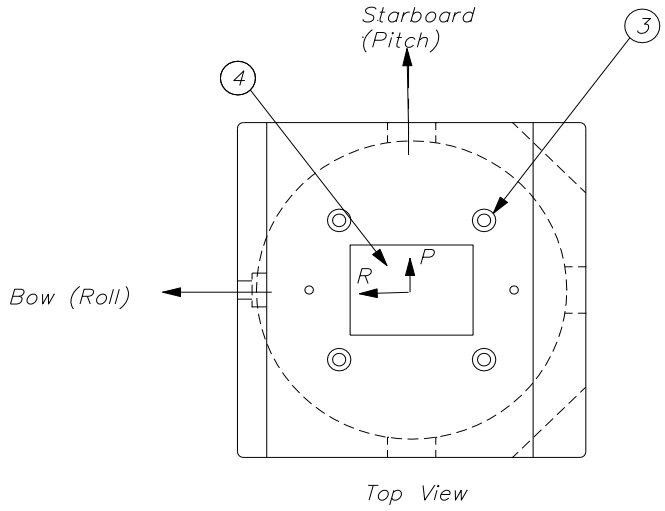


Figure 14 Sticker (4) shall indicate actual MRU mounting orientation within bracket

Note *If the MRU is mounted correctly in the bracket, the +R arrow on the top of the MRU will point in the bow direction of the ship and the same direction as the R-axis of the sticker. If uncertain whether the MRU R-axis is pointing in the bow direction, look under the MRU and check that the +R arrow label is pointing in the bow direction. Precise MRU orientation is important to ensure that high quality and accurate measurements are available to the host system*

5 Mount the junction box on the wall in a suitable location within the length of the 3-metre MRU-E-CS1 cable, as shown in Figure 15 MRU junction box mounting

6 The screws for mounting the junction box should be secured with washers or self-locking nuts.

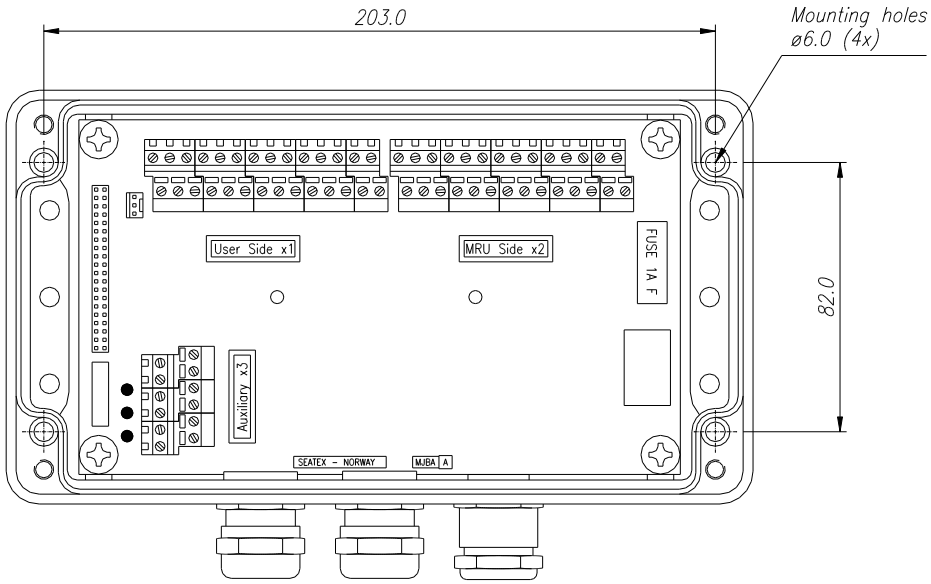


Figure 15 MRU junction box mounting

7 Mount the Processing Unit in a standard 19-inch rack in a preferred location. The Processing Unit has to be fastened both in front and rear of the rack. Minimum 10 cm free space is needed behind the module for connection of cables.

8 Mount the HMI Unit in a standard 19-inch rack in a preferred location. The HMI Unit has to be fastened both in front and rear of the rack. Minimum 10 cm free space is needed behind the module for connection of cables.

3.4.2 Electrical installation

The electrical installation consists of:

- Connecting two cables between the GNSS antennas and the Processing Unit.
- Connecting a cable between the MRU junction box and the Processing Unit.
- Connecting an Ethernet cable between the Processing and the HMI Unit.
- Connecting the monitor, the keyboard and the PC mouse to the HMI Unit.
- Connecting cables with output data between the Processing Unit and external equipment (optional).
- Supplying 110/240 V AC power to the Processing Unit, the HMI Unit and the monitor.

3.4.2.1 Installation procedure

Caution *Attach the antenna cables to the GNSS antennas on the Bracket before attaching the antenna cables to the Processing Unit. If the antenna cables are attached to the Processing Unit, do not attach the antenna cables to the GNSS antennas with the Processing Unit powered on. If the antenna cables are short-circuited with power on, the GNSS receivers within the Processing Unit will be damaged.*

1 Connect the two GNSS antenna cables to the connector 1 (for GNSS antenna 1) and connector 2 (for GNSS antenna 2) at the rear of the Processing Unit.

→ *See APPENDIX B on how to install the coax connector on the Superflex antenna cable.*

→ *See APPENDIX C for more details on how to install the GNSS antennas.*

2 Wrap outdoor cable connections with waterproof self-vulcanising tape. An alternative way of waterproofing is to use heat shrink hose with glue. The hose should cover the whole connector and part of the cable.

Note *The GNSS antenna cables must be as straight as possible. Do not crush or crimp the cable with tie-downs as this will affect the electrical properties of the cables.*

3 Enter the cable from the MRU port at the rear of the Processing Unit through one of the free nipples on the junction box. Ensure that the cable shield is in contact with the nipple for grounding before the cable is fastened to the box. Use the required number of clips to fasten the cable to the wall.

4 Insert each of the MRU to Processing Unit cable wires into the correct terminal on the user side (x1) and all cable shields to pin 1 (chassis) on the auxiliary contact side (x3) within the box. Ensure that the shield around each pair in the cable is individually isolated on the 10 pin terminal. The outer shield is connected to pin 3 (screen) on this terminal, which is an open end (not connected to earth).

5 Insert an isolated wire between pin 24 (LGND) and pin 27 (Shutoff) on the user side (x1) in the junction box. By connecting these two pins, the communication with the MRU will switch from RS-232 to RS-422.

Note *It is important to insert a wire between pin 24 (LGND) and pin 27 (Shutoff) on the user side (x1) in the MRU junction box in order to*

establish RS-422 communication between the MRU and the Processing Unit. Otherwise there will be no communication between these two components.

Note *The junction box housing is grounded to earth through the screws for mounting the box to the wall or floor. Please note that if the foundation on which the junction box is mounted, is NOT connected to earth, one of the junction box mounting screws has to be connected to earth by connecting a wire from the screw to an object that is connected to earth.*

|----------User side x1----------|

pin	signal	description
1	PWRIN+	power +
2	PWRIN-	power gnd
3	TX+	from MRU
4	TX-	-"-
5	RX+	to MRU
6	RX-	-"-

pin	signal	description
23	XIN	to MRU
24	LGND	gnd ref.aux.+dig
27	SHUTOFF	of MRU

6 Connect the cables for output data from Seapath to external equipment to the Com ports 1 and 2 or the terminals Com9 to Com14, analog output signals or the Ethernet connection.

Note *Cable with shield has to be used in order to fulfil the Seapath power and EMC requirements.*

7 Connect the 110/230 V AC ship's power supply to the power connector at the rear of the Processing Unit.

8 Connect the 110/230 V AC ship's power supply to the power connector at the rear of the HMI Unit.

9 Connect the cable from the monitor, PC mouse and the keyboard to the corresponding connectors at the rear of the HMI Unit.

10 Connect the monitor for the HMI Unit to 110/230V AC ship power.

11 If available, connect the signal cables with DGNSS correction and external gyro compass to free terminals at the rear of the Processing Unit.

12 Connect an Ethernet cable from the LAN port on the rear of the Processing Unit and the HMI Unit to the network onboard the vessel or a direct connection between the two units.

13 When all cables are connected, power on the Processing and HMI Units, the four LED indicators located on the front panel of the Processing Unit should then start to shine red. The LED1 light diode in the MRU junction box should then shine green indicating that the MRU receives power. A yellow light in LED2 indicates that digital data are sent from the MRU on TX+.

14 If the software starts on both the Processing and the HMI Unit, the installation is now completed and the setup of the configuration parameters can continue.

3.4.3 Setup of configuration parameters

Setup consists of:

- Entering lever arm vectors and mounting angles for the MRU and the GNSS antennas in the NavEngine configuration of the operator software.
- Entering input and output data interface in the NavEngine configuration of the operator software.

The setup parameters are entered into the operator software on the HMI Unit.

→ *See chapter 4.1. for a description of the operator software.*

3.4.3.1 Lever arm vector determinations

The following lever arm vectors have to be determined and input to the operator software:

- The vector from the selected AP to the GNSS antenna no. 1.
- The vector from the selected AP to the MRU location.
- The vectors from the selected AP to each of the monitoring points (maximum eight MPs).

All these vectors have to be measured or calculated based upon drawings or previously measured points. These vectors are to be measured within an accuracy described in chapter 3.3.5. Positive vector orientation for these parameters is X - positive forwards, Y - positive towards starboard, Z - positive downwards with the AP (Aft Perpendicular) as the origin.

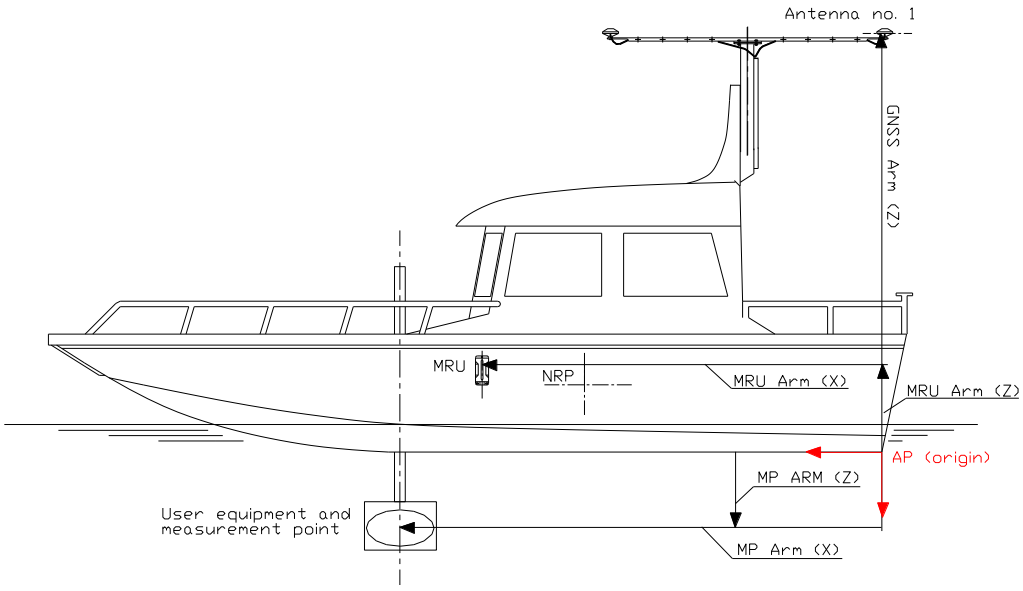


Figure 16 Offset vectors between the different components

3.4.3.2 Setup procedure

1 Power on both the Processing and HMI Units and follow the configuration procedure for the operator software described in chapter 4.1.

2 Edit the Seapath parameters and Apply in order to download the entered configuration parameters to the Processing Unit. For more description of each of the configuration parameter selections, see chapter 4.4.

3.4.4 Calibration

The system has to be calibrated on board the vessel after installation. A typical calibration consists of:

- Calibrating the direction of GNSS antennas against an external reference. Type of reference must be decided according to the required accuracy.
- Calibrating the MRU axes measured by the MRU against an external reference. Decision on whether MRU calibration is needed and type of reference, is based on the type of system to which the Seapath is interfaced and the accuracy required.

3.4.4.1 Calibration of the GNSS antenna installation

For the GNSS antenna installation the following calibration parameters have to be determined:

- **Baseline Length**. The baseline length between the two antennas is measured in metres. The length can be selected in the range 0.2 to 6.0 metres, but the recommended antenna baseline length range is 2.5 to 4.0 meters.

- **Heading Offset**. The direction of the GNSS antennas relative to the vessel's longitudinal axis is measured in degrees.
- **Height Difference**. The height difference between the two antennas according to the vessel horizontal plane (the height to antenna #1 minus the height to antenna #2, compensated for vessel roll and pitch) is measured in metres. This is an absolute value (always positive).

It is of crucial importance to calibrate the heading offset correctly. During this calibration, several accurate reference measurements of the vessel heading must be read/logged simultaneously with the heading output from the Seapath. The data logging should continue for at least two hours under calm conditions alongside a quay. The best results are achieved if continuous logging of both the reference system and the Seapath measurements can be performed during the calibration period. If simultaneous logging of the two systems is not possible, one reading from both systems should be done at least every 30 seconds for a minimum of two full hours.

The long calibration time is necessary in order to cancel out errors in the Seapath measurements caused by multipath effects, which may be particularly pronounced in the static conditions of a harbour area.

Before calibration, measure the baseline length between the GNSS antennas to within a tolerance of one centimetre or better. If the standard antenna bracket is used, the baseline is 2.5 metres. Enter the measured baseline length into the Processing Unit by using the operator software.

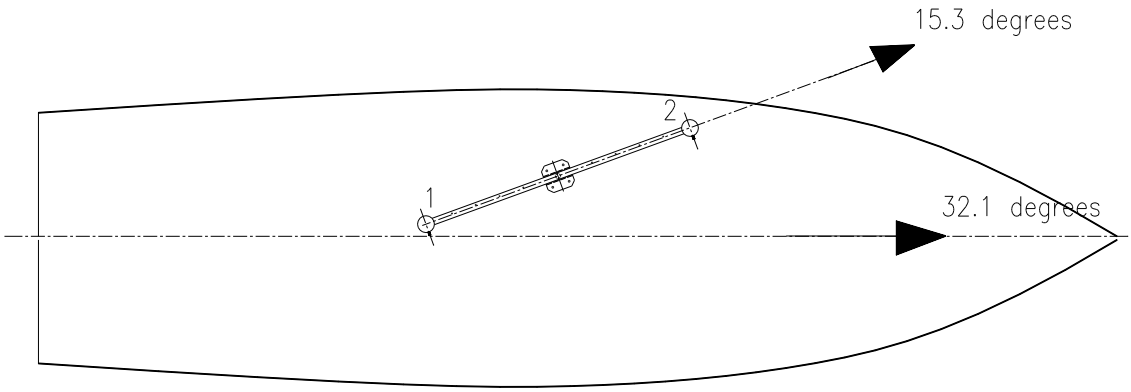
The observations from each of the two different systems are then averaged and the offset between the two systems (reference minus Seapath reading) is the Seapath heading offset. If heading offset was not entered as zero in the operator software on beforehand, the calibration value should be added to the existing offset value.

The baseline length and height difference should be determined within an accuracy of 10 centimetres in height difference and 1 mm in baseline length. These values should be entered into the Seapath through the operator software configuration dialog under NavEngine configuration in the **System** menu. By using the calibration wizard in the operator software the baseline length and height difference are calculated automatically.

Note *Before starting the calibration wizard, the MRU mounting angles have to be correct and used by the Seapath (applied before entering the calibration wizard). Else the calculation of the height difference will be incorrect, unless the vessel has zero roll and pitch. Incorrect height difference will degrade the heading accuracy.*

Example:

If the heading measured by the reference system is found to be 32.1 degrees and the Seapath heading after the calibration has been determined to be 15.3 degrees, the Seapath heading offset to be input in operator software is the value 16.8 (32.1 - 15.3).

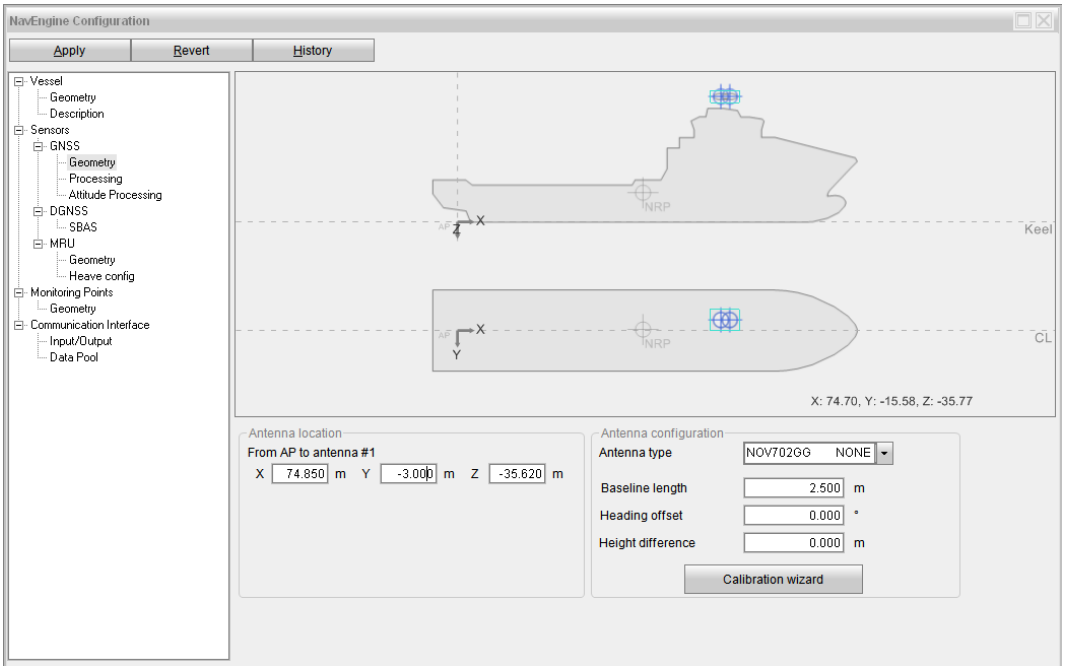


3.4.4.2 Typical calibration procedure

This is an example on how to perform a GNSS antenna calibration. Proceed as follows:

1 Before entering the calibration wizard, ensure that the correct MRU mounting angles are used by the Seapath (press **Apply** on MRU mounting angle changes before entering the calibration wizard). Else the calculation of the height difference in the calibration wizard will be incorrect, unless the vessel has zero roll and pitch. Incorrect height difference will degrade the heading accuracy.

2 Select the **System** menu and NavEngine to enter the NavEngine configuration dialog. Select Sensors\GNSS\Geometry as shown in the figure below.



3 In the Antenna configuration window, input the Baseline length 2.5 metres if the standard Antenna Bracket is used, otherwise this length has to be measured manually with 1 cm accuracy and this value entered. For the Antenna orientation input an approximate value or input zero if you are uncertain. For the Height difference input an approximate value. Then click on the **Calibration wizard** button to prepare the calibration.

4 In the Antenna calibration wizard – Page 1 Input Parameters, Step 1 check that the baseline length has been entered correctly.

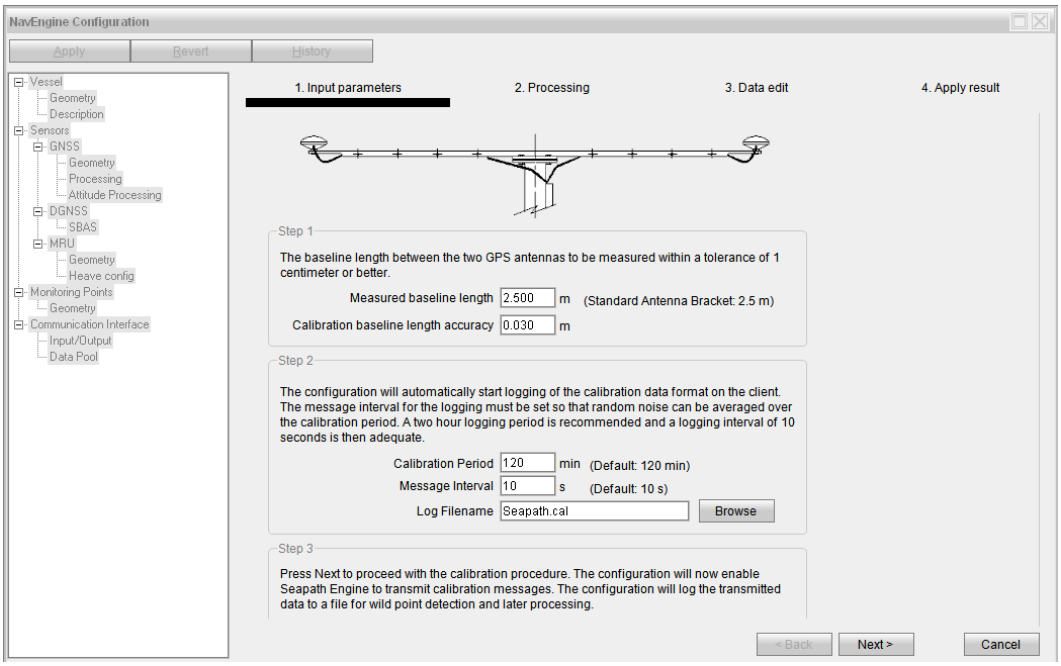

NavEngine Configuration
Apply
Revert
History
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
MRU
Geometry
Heave config
Monitoring Points
Geometry
Communication Interface
Input/Output
Data Pool
1. Input parameters
2. Processing
3. Data edit
4. Apply result
Step 1
The baseline length between the two GPS antennas to be measured within a tolerance of 1 centimeter or better.
Measured baseline length 2.500 m (Standard Antenna Bracket: 2.5 m)
Calibration baseline length accuracy 0.030 m
Step 2
The configuration will automatically start logging of the calibration data format on the client. The message interval for the logging must be set so that random noise can be averaged over the calibration period. A two hour logging period is recommended and a logging interval of 10 seconds is then adequate.
Calibration Period 120 min (Default: 120 min)
Message Interval 10 s (Default: 10 s)
Log Filename Seapath.cal
Browse
Step 3
Press Next to proceed with the calibration procedure. The configuration will now enable Seapath Engine to transmit calibration messages. The configuration will log the transmitted data to a file for wild point detection and later processing.
< Back
Next >
Cancel

Figure 17 Page 1 of GNSS antenna calibration

5 In Step 2 input 120 minutes (two hours) as the calibration period and the logging interval as 10 seconds. Log the calibration data to the file "Seapath.cal" on a preferred folder on the PC.

6 Before pressing **Next** and start logging of Seapath GNSS, it is recommended to start recording data of the vessel reference heading on another PC or by manual readings. When logging of the reference heading has started, click **Next** in order to proceed to page 2 Processing.

7 The progress of the calibration process is then shown on the screen with a graphical presentation of the measured data for the Seapath heading, the gyro compass (if connected), the antenna baseline length and the height difference.

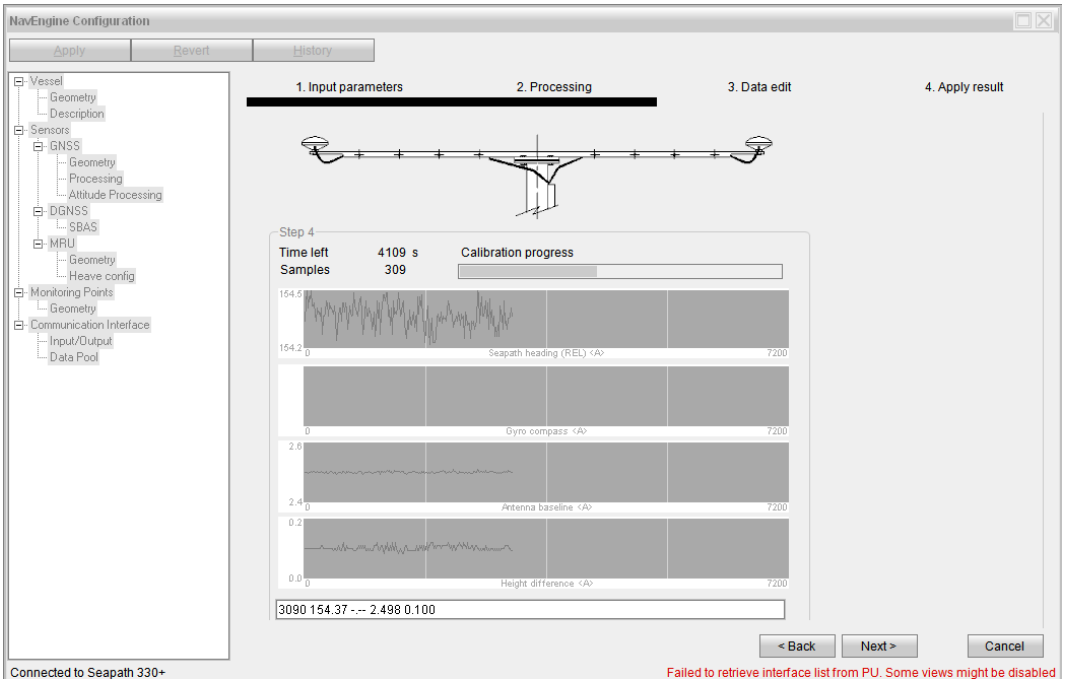


Figure 18 Page 2 of antenna calibration wizard

8 Click **Next** to proceed to page 3 Data edit for information about the calibration result.

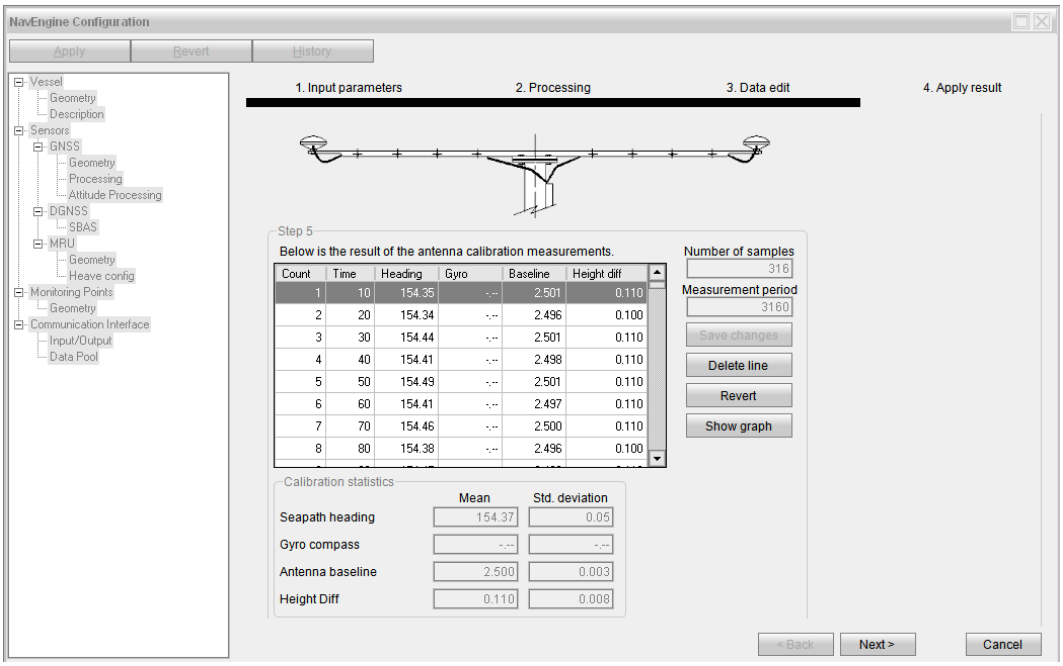


Figure 19 Page 3 of antenna calibration wizard

9 Inspect the logged calibration data (in the file "Seapath.cal") for any wild points by selecting the command **Show graph**. Correct the wild points found or delete the whole line(s) and perform a recalculation of the calibration data.

10 When the Seapath calibration result has been found acceptable, click **Next** to proceed to page 4. Input the mean value for the vessel heading reference, in this example logged on a separate PC and found to be 160.00 degrees, and click on **Compute** in order to calculate the heading offset.

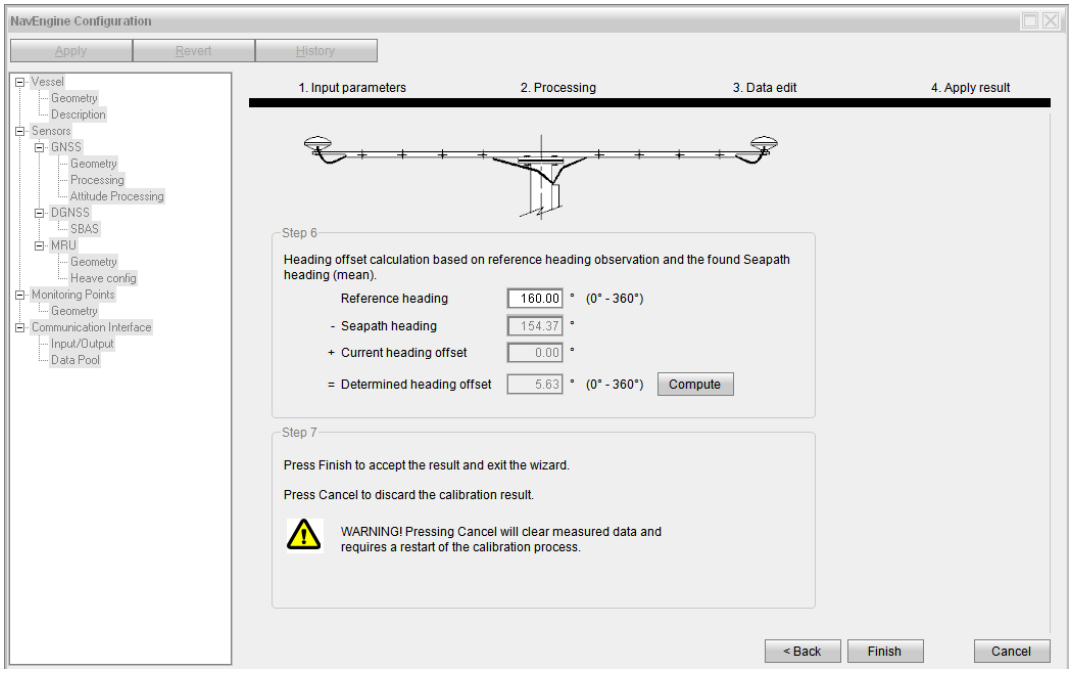


Figure 20 Page 4 of antenna calibration wizard

11 Click **Finish** to accept the result and exit the antenna calibration wizard.

3.4.4.3 Calibration of MRU axis

After the mechanical installation is completed, the MRU R, P and Y axes must be aligned to the corresponding vessel axes or the axes of the system to be compensated. To achieve the MRU's specified roll and pitch accuracy, any misalignment of the MRU axes with the vessel axes must be precisely calculated and accounted for. The MRU axes, and particularly the yaw axis, must be aligned with the vessel axes with an accuracy better than 0.5 degrees to ensure that the MRU functions are according to specifications. For multibeam echo sounder applications an accuracy better than 0.1 degrees is required to ensure satisfactory performance.

A typical alignment process consists of aligning the MRU axes to an external reference. Type of reference must be determined according to the required accuracy.

The reference for roll and pitch alignment must be carefully selected depending on the intended application. It may be the hull, a sensor such as a multibeam echo sounder or a USBL acoustic system. Some sensors have internal alignment routines, and accurate alignment of the MRU is not required. The MRU mounting wizard is described later in this manual. This includes an automatic procedure for obtaining the roll and pitch mounting angles.

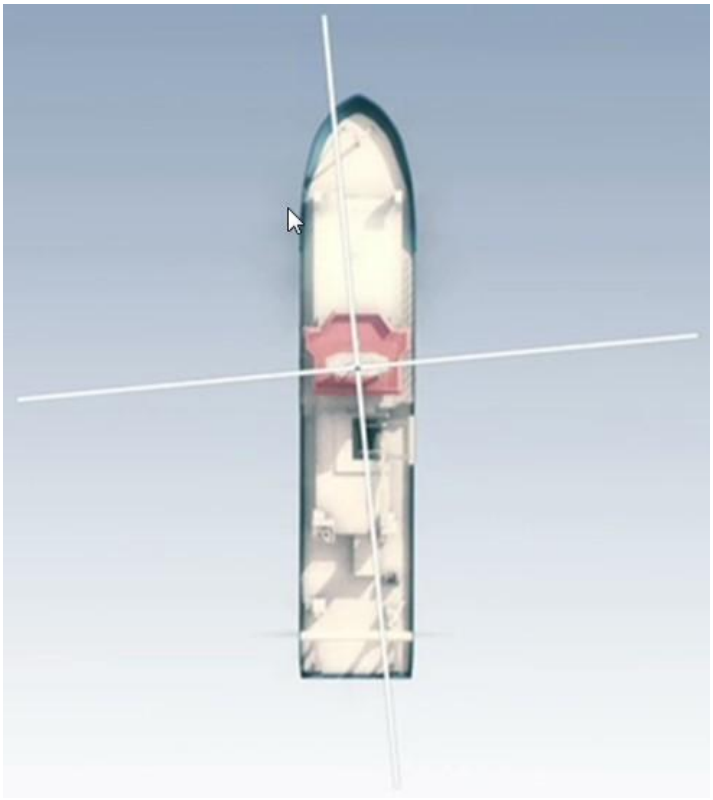


Figure 21 Alignment of MRU yaw axis to vessel longitudinal axis

An accurate alignment of the MRU +R arrow towards the vessel's longitudinal axis (yaw orientation) is of special importance. If not properly aligned, the performance of the roll and pitch measurements from the MRU will be degraded. Figure 22 illustrates that a misalignment of 1 degree of the MRU in yaw will result in a roll error of ±0.09 degrees if the vessel is pitching ±5 degrees. To calculate the misalignment of the MRU axis to an accuracy of 0.5 degrees or better is not an easy task and requires use of an accurate external reference.

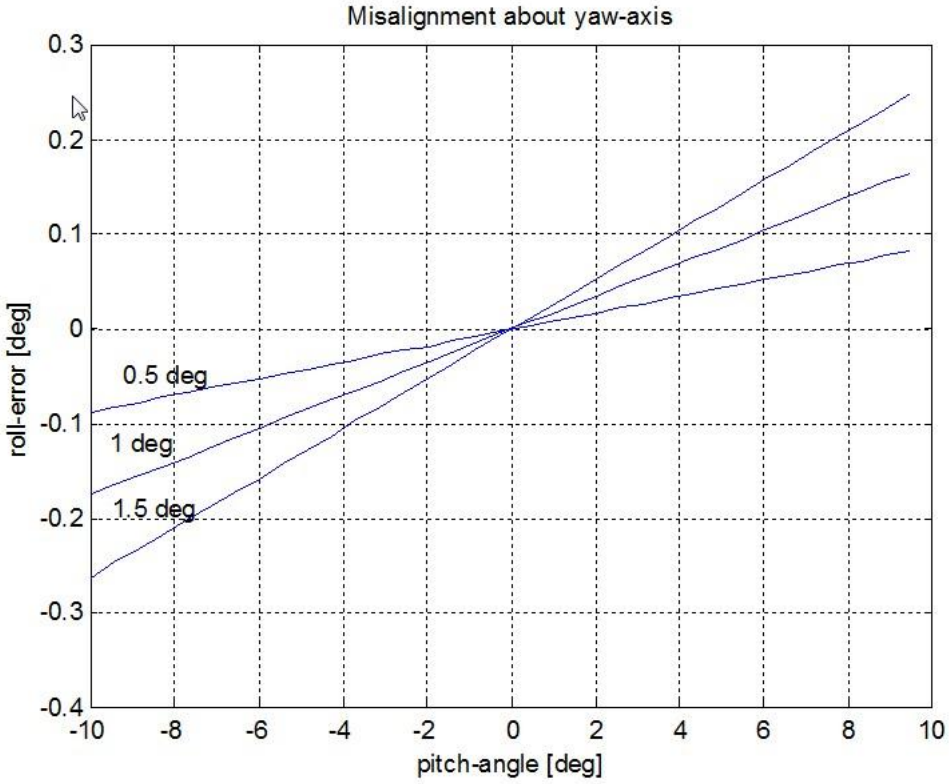


Figure 22 Value of roll error as a function of vessel pitch angle, displayed at 0.5°, 1° and 1.5° MRU yaw misalignment

4 CONFIGURATION

Seapath has a graphical user interface which includes configuration, data presentation and sensor status. This chapter describes the Seapath configuration management system.

4.1 Starting the system

After installing the equipment according to the procedures, the system can be started. Press the power switch on the front of the Processing and HMI Units to start the systems.

The system will start automatically after power on. Normally, the unit will output signals on the serial lines without any involvement from the user.

4.2 System configuration

4.2.1 System modes

The product has three system modes, indicated in the System mode field of the **Top bar**:

Operation mode This is the default mode. In this mode it is not possible to launch any external applications, diagnostic tools or reconfigure the system.

Configuration mode In this mode it is possible to change settings related to the connected sensors, applications and system-wide settings.

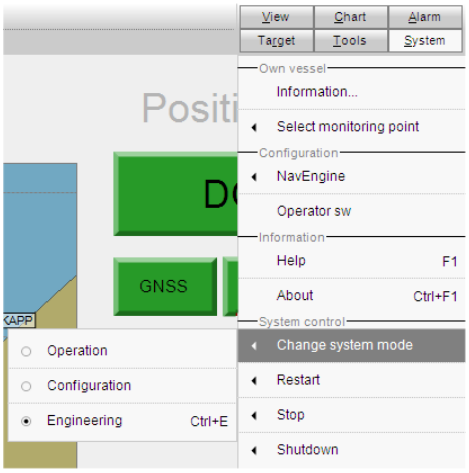


Figure 23 Change system mode menu

Engineering mode This mode is primarily intended for field engineers during initial installation, fault diagnostics and system-wide reconfiguration.

A password is required to switch from Operation to Engineering or Configuration mode. The password is "stx", and it is not possible to change. The system will return to Operation mode after 3 minutes of user inactivity.

4.3 NavEngine configuration

From the **System** menu, configuration of NavEngine is available. Two modes of configuration are available, **Standard** and **Advanced**. The Standard configuration is available when logged into Configuration mode, while the Advanced configuration is available in Engineering mode.

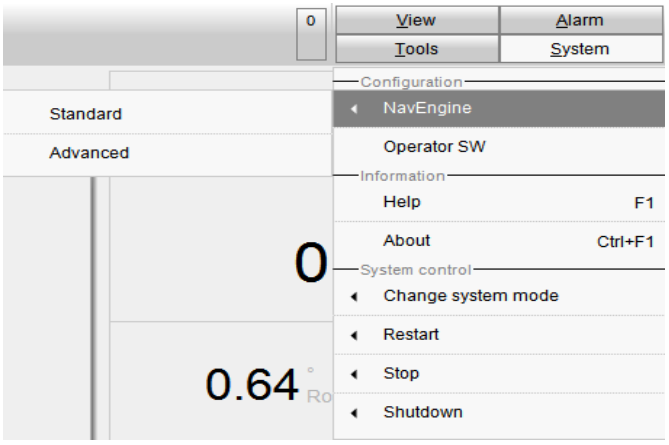


Figure 24 NavEngine configuration

4.4 Standard configuration

When **Standard** configuration is selected from the **System** menu, the **NavEngine Configuration** view is displayed.

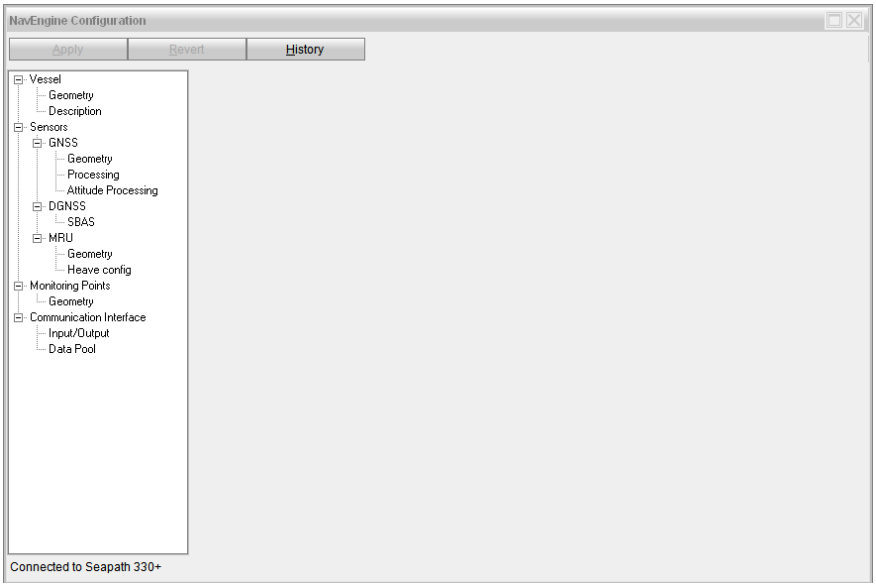


Figure 25 NavEngine Configuration view

At the top of the **NavEngine Configuration** view there are three buttons to handle the configuration parameters.

Apply To save the parameter settings, the **Apply** button must be pressed.

Revert The **Revert** button contains the last applied configuration parameters.

History A new configuration file is stored each time the **Apply** button is pressed. From the **History** button, the saved files are available. The files are named with the date and time they were saved. The ten last files are displayed in the list. Via the **Browse…**button at the bottom of the list it is possible to find all saved files.

Figure 26 History button

The following parameters can be set in the Standard configuration:

- Vessel geometry and description
- Sensor data, including:
  - GNSS geometry and processing
  - DGNSS and SBAS
  - MRU geometry and heave config
- Monitoring points geometry
- Communication interface, including:
  - Input/Output
  - Data pool

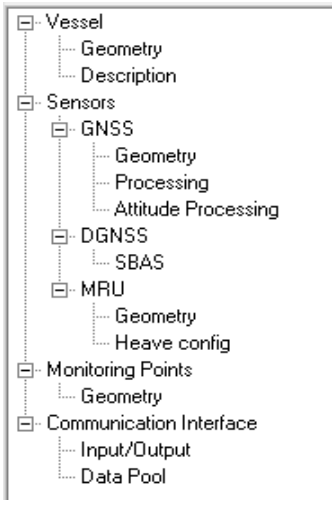


Figure 27 Configuration manager

4.4.1 Vessel configuration

In the Vessel configuration the following can be input:

Geometry For later configuration of sensor and monitoring point locations on the vessel it is an advantage that the background vessel (vessel shape) is as equal as possible to the vessel on which the system is installed. The background vessel is scaled on the screen to be equal to the installed vessel. To scale the vessel shape on the screen to the actual vessel, its dimensions have to be input.

Description Vessel data for the specific installation. This information is helpful to identify the correct configuration file at a later stage.

4.4.1.1 Vessel geometry

The Vessel Geometry view defines the vessel dimensions.

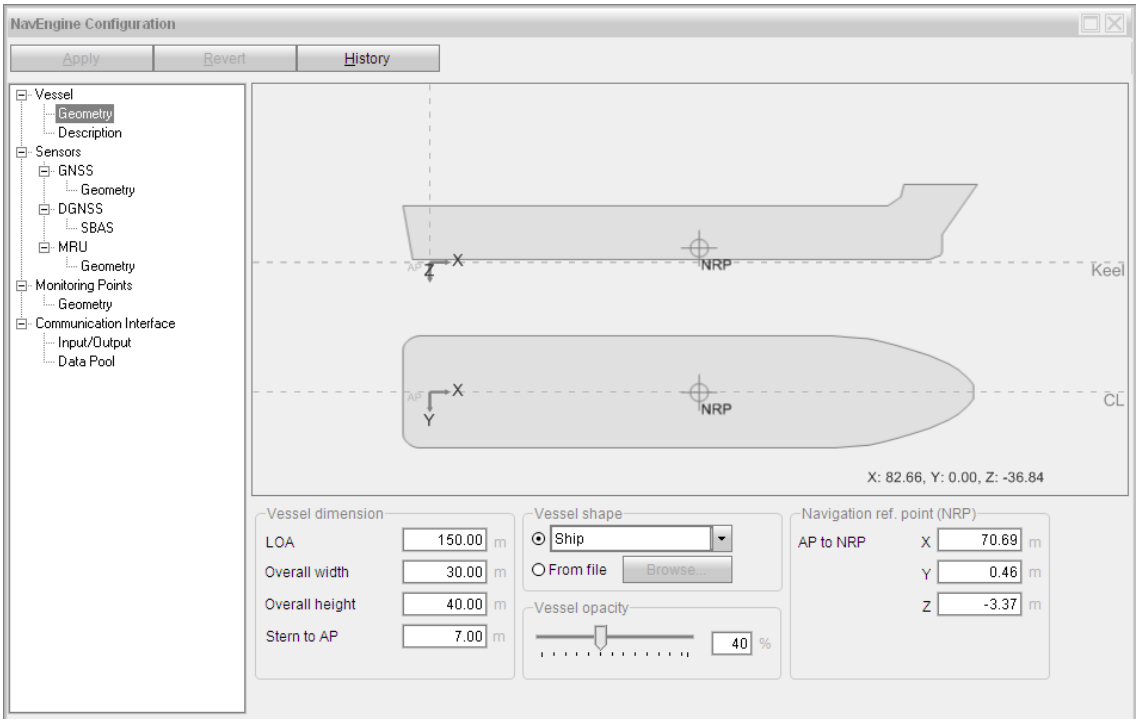


Figure 28 Vessel geometry view

In the **Vessel dimension** section it is possible to set the following parameters:

LOA The overall length of the vessel, i.e. from stern to bow [m].

Overall width The overall width of the vessel [m].

Overall height The distance from the highest point of the vessel to the keel [m].

Stern to AP The distance from the aft point of the ship to its AP [m].

In the **Vessel shape** section it is possible to select the vessel shape or to get the vessel shape from a file.

Vessel shape	The vessel shapes supported are ship, rig and jackup.
From file	Input of vessel shape from file, see separate section.
Vessel opacity	A percentage scaling of the opacity of the vessel shape on the screen.

In the **Navigation ref. point (NRP)** section, the distance between AP and NRP is defined.

AP to NRP	The distance from AP to NRP [m]. The Navigation Reference Point location (NRP) is the reference point for all measurements in the system. The recommended used NRP is the vessel CG or rotation centre.

4.4.1.2 Vessel shape

For later configuration of sensor and monitoring point locations on the vessel, it is an advantage that the vessel is of the same shape as the vessel where the system is installed. The background vessel is scaled on the screen to be equal to the installed vessel. By moving the PC mouse around on the vessel, the coordinates (x,y,z) will be shown in full scale. For later configuration of sensors and monitoring points, just place the PC mouse on the screen on the spot where the sensor or monitoring point is wanted and the coordinates for this point are then automatically defined.

It is possible to select a pre-defined shape of the vessel, which is ship, rig or jackup, or to define the shape from **File** as a **User Bitmap** or **User Text** with 2D description of the vessel.

To input **Vessel shape** from file as user text, proceed as follows:

1 When generating the vessel image from file, the following data format and structure is to be used:
   - The vessel data have to be in an ASCII file generated by Excel, Notepad or similar tools.
   - The file head includes LOA, Overall width, Overall height and Aft to AP data in metres.
   - Profile data in X and Z coordinates in metres. The first coordinate has to be for AP and start with 0.00 and the last coordinate has also to be AP end with 0.00.
   - The top view data in X and Y coordinates in metres. The first coordinate has to be for the aftermost point on the vessel and on the centre line. The last coordinate has to be the foremost point on the vessel and on the centre line. Only data for the starboard side of the vessel should be input since a vessel is symmetric along the centre line.

2 A typical example of a vessel data file is shown below:

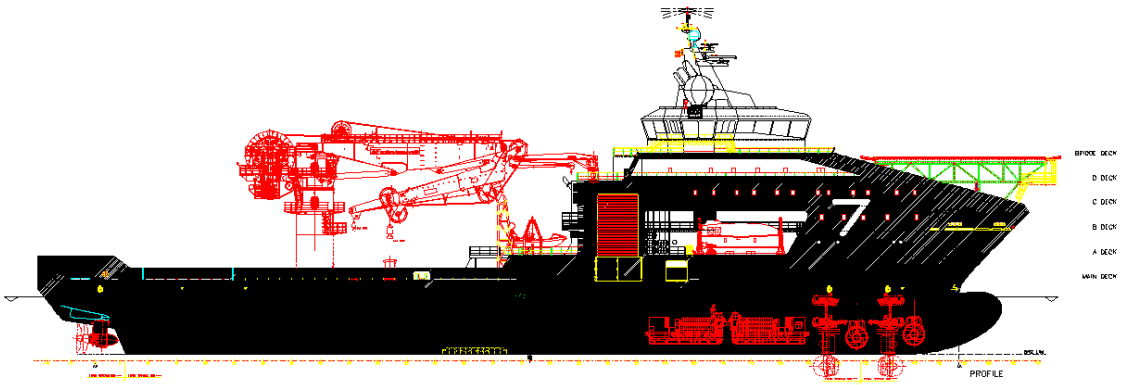


Figure 29 Example GA drawing of multi-purpose vessel

mpv.txt - Notepad

File Edit Format View Help

```
%Vessel Data [m]
%LOA = 120.70
%Width = 23.00
%Height = 32.20
%Aft to AP = 7.00
%Profile coordinates in (X,z) [m]
0.00,-3.55
2.44,-3.19
3.69,0.00
98.60,0.00
101.00,-0.14
105.20,-1.12
108.36,-2.70
110.09,-4.51
110.35,-5.20
110.40,-5.43
110.40,-5.69
.
.
.
.
63.10,-24.00
63.10,-21.00
59.62,-21.00
59.62,-15.13
57.87,-12.00
50.50,-12.00
49.65,-10.50
4.25,-10.50
2.31,-12.00
-7.00,-12.00
-7.00,-8.00
-4.00,-4.11
0.00,-3.55

%Top view coordinates in (X,Y) [m]
-7.00,0.00
-7.00,11.50
90.30,11.50
.
.
.
113.60,0.57
113.70,0.00
```

Figure 30 Example of vessel shape in user text file

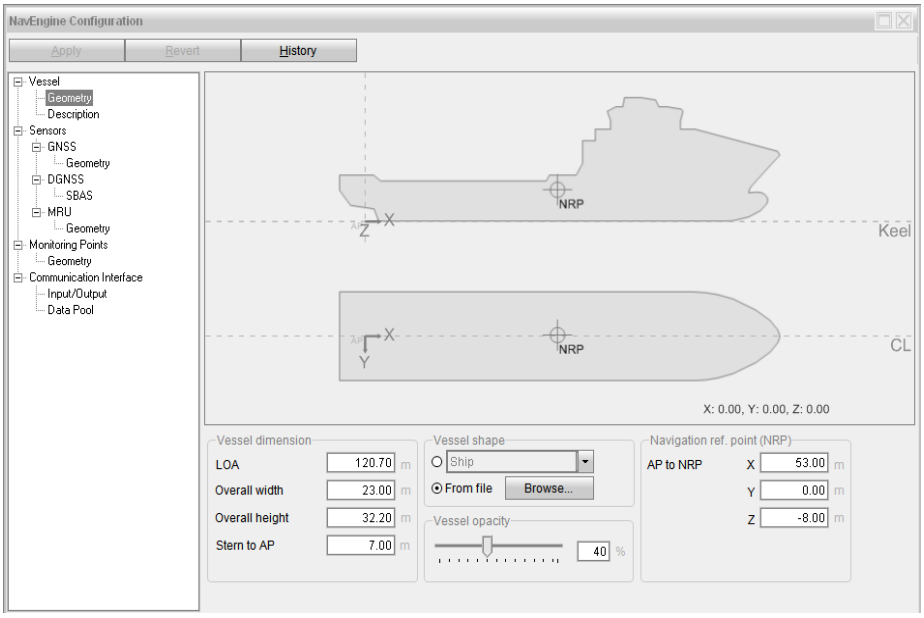


Figure 31 Example vessel shown in Vessel Geometry view

4.4.1.3 Vessel description

The Vessel Description view contains mostly textual information regarding the vessel.

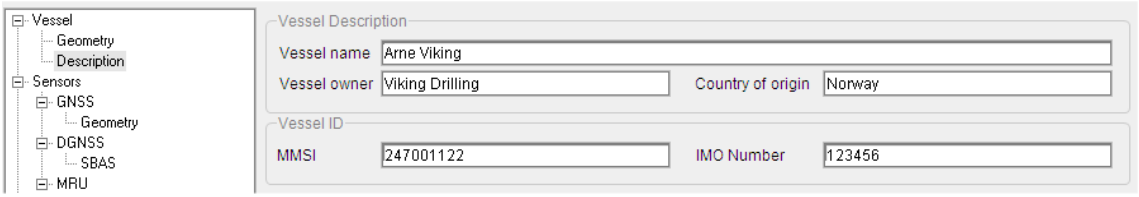


Figure 32 Vessel Description view

Vessel name The name of the vessel.

Vessel owner The name of the vessel owner.

Country of origin The name of the vessel's country of origin.

MMSI The MMSI assigned to the vessel.

IMO Number The IMO ID assigned to the vessel.

4.4.2 GNSS configuration

4.4.2.1 GNSS Geometry

The lever arm vector from the AP to GNSS antenna no. 1 has to be measured or calculated based upon drawings or previously measured points, and entered into the software. The antenna cable connected to GNSS1 at the back of the Processing Unit will be GNSS antenna no. 1 in the installation. Proceed as follows:

- **Antenna location**. Set the **Antenna location** coordinates for the GNSS antenna which is defined to be antenna no. 1, normally the antenna closest to the aft of the vessel. Check that the antenna has been located on the expected spot in the vessel shape. If not, check the signs and the co-ordinates input for GNSS antenna no. 1, the vessel dimension and the entered location of AP.
- **Antenna configuration**. In the **Antenna configuration** section, input the antenna type (Novatel NOV600, NOV702 or NOV702GG or GENERIC. NONE means no antenna dome or choke ring included), baseline length 2.5 metres if the standard Antenna Bracket is used, otherwise this length has to be measured manually and this value entered. For the heading offset and height difference input zero. Then click on the **Calibration wizard** button to prepare the calibration. The Heading Offset and Height Difference is automatically updated trough the Calibration wizard process. Check that the orientation of the antennas in the vessel shape correspond with the actual orientation in the mast. See the chapter Calibration for description on how to use the Calibration wizard.

Note *Correct selection of antenna type is only important when raw GNSS data are output from the Seapath for post-processing of the position accuracy. The selection GENERIC as antanna type is used for all single-frequency antennas (L1) and for Seapath installations that shall not use RTCM output for post-processing. If other antennas than those listed are used, check the following link to find the correct antenna type; ftp://igscb.jpl.nasa.gov/igscb/station/general/rcvr_ant.tab. Other antenna types than those listed are input in the Seapath configuration by using the **Advanced** option in **NavEngine configuration** on the System menu.*

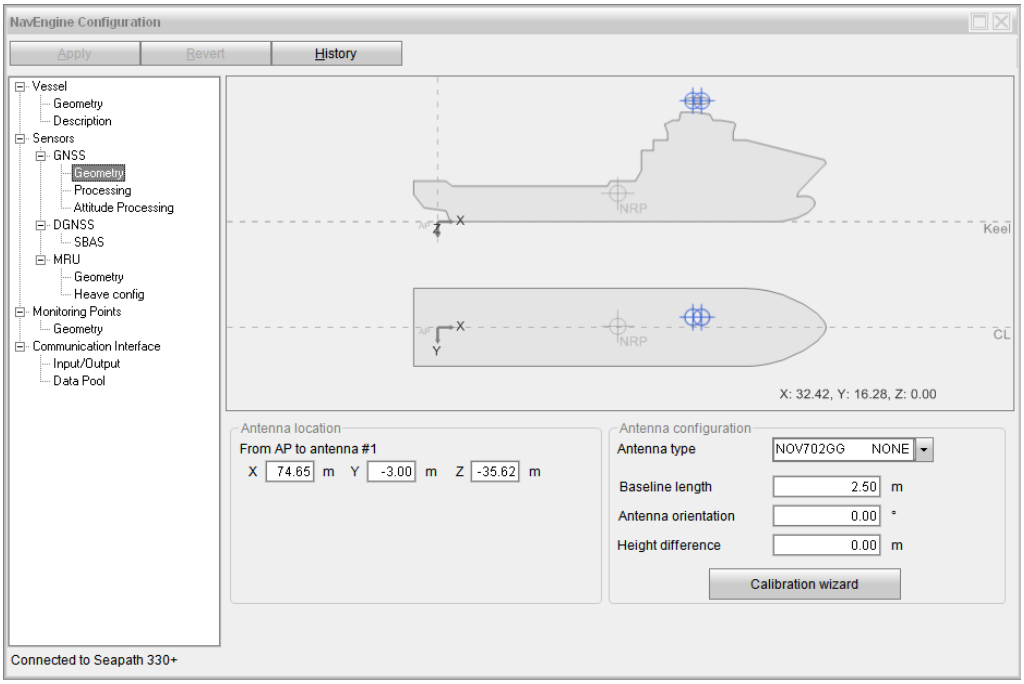


Figure 33 GNSS sensor geometry configuration view

4.4.2.2 GNSS Processing

For operations with weak satellite geometry the position output can be made more accurate by using height aiding and low elevation mask. For normal operations the Height Aiding mode is set to Off but Filter is also recommended used. The elevation mask is set to 10 degrees as the default value and must not be changed by other than experts. For the Seapath 330 models the search mode for the RTK solution has three selections: Safe, Normal and Fast. The default RTK search mode is Normal. In order to change the default GNSS Processing settings, proceed as follows:

- Set the Seapath in Height Aiding mode by pulling down the Aid Mode drop-down list and change the selection from Off, which is the default setting, to Filter. The Aided Height is the height of NRP above sea level. This height should be set when Filter is selected since the filter will start with the entered height value as the initial value.
- The SV masking value can be changed from the default value 10 by entering an Elevation mask value between 7 and 20 degrees. This value must not be changed by other than experts from the default value 10.
- Click the checkbox **Enable range rate corrections** to use the DGNSS corrections in the GNSS velocity calculations. The default setting is enabled on use of range rate corrections. Disabling range rate corrections will reduce velocity and attitude noise when receiving DGNSS corrections from a reference station with a noisy range rate.
- For the Seapath 330 models the search mode for the RTK solution should be changed from the default mode Normal to Safe or Fast by pulling down the RTK search mode

drop-down list. The Safe mode is recommended used under difficult conditions with much multipath or ionospheric activity and for long baselines. The Fast mode is used when a fast RTK solution is required. However, in this mode the probability for an incorrect solution from the system increases.

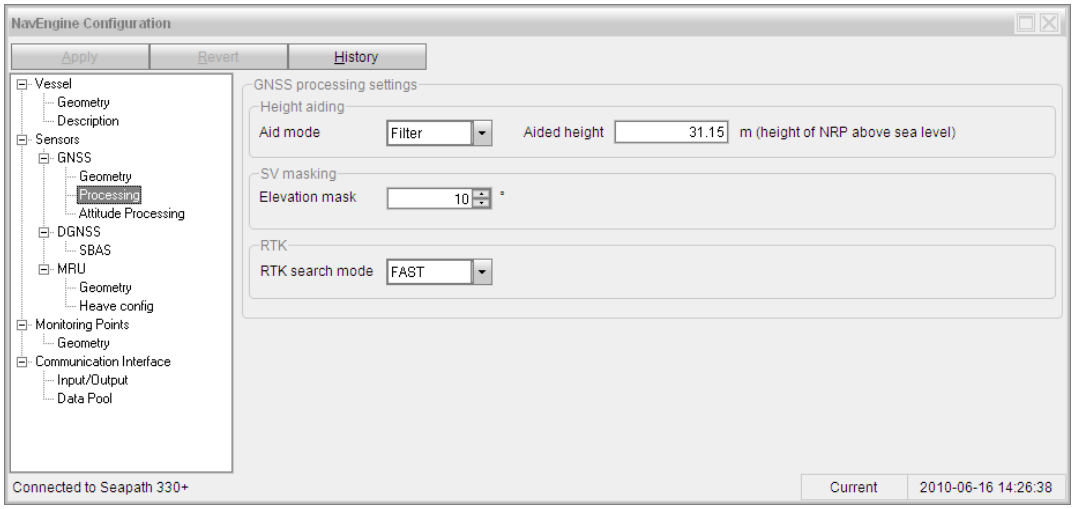


Figure 34 GNSS Processing settings view

4.4.2.3 GNSS Attitude Processing

In this dialogue the maximum values to be used for attitude processing can be changed. However, these parameters are only to be changed if the vessel has an unusual characteristic.

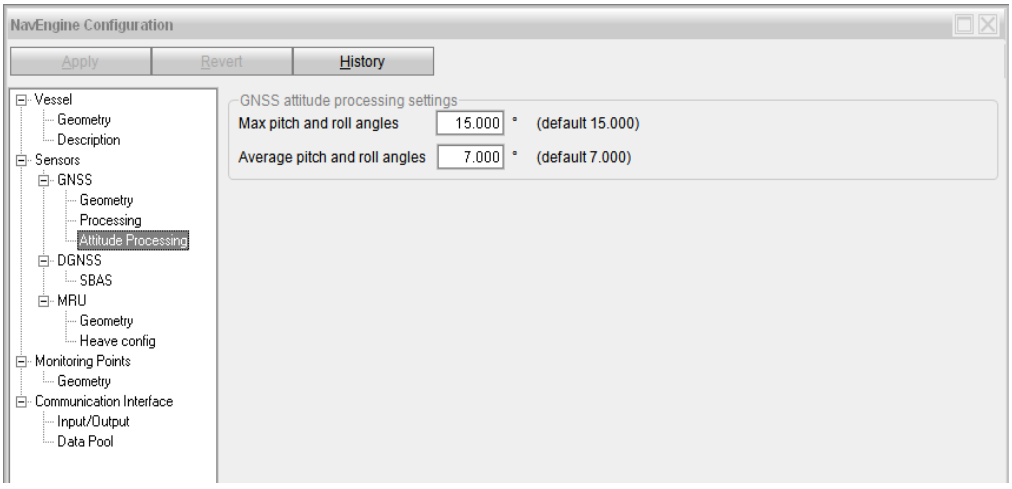


Figure 35 GNSS Attitude Processing view

4.4.3 DGNSS configuration

4.4.3.1 SBAS tracking

In the SBAS tracking view it is possible to set up Automatic or Manual tracking of SBAS satellites. When Automatic tracking is selected, the GNSS receiver chooses which SBAS satellites to track.

In Manual mode the user must set up which SBAS satellites to use. If two SBAS satellites are selected, the system will automatically select and use data from the best satellite. If only one SBAS satellite is selected, only correction data from this satellite will be used in the computations.

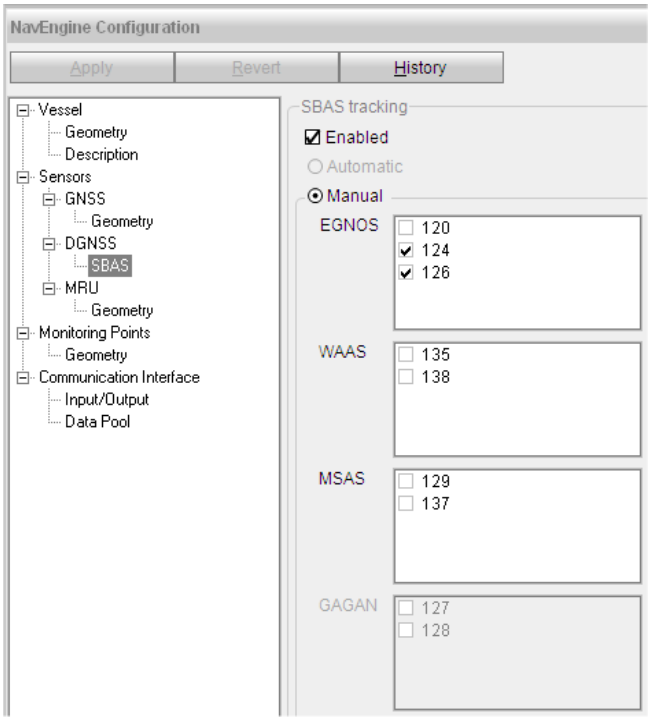


Figure 36 SBAS tracking view

If no specific SBAS satellite is selected, the system will select and use data from the best of the available satellites.

If the selected SBAS satellite is not available, the system will not use the SBAS correction data in the computations.

Maximum two SBAS satellites may be tracked by the GNSS receiver.

4.4.4 MRU configuration

4.4.4.1 MRU Geometry

The lever arm vector from the AP to the MRU location has to be measured or calculated based upon drawings or previously measured points, and entered into the software. Look at the sketch of the MRU geometry on the screen in order to enter correct signs on the co-ordinates. Check also that the MRU has been located on the expected spot in the vessel shape. If not, check the signs and the co-ordinates input for the MRU, the vessel dimension and the entered location of AP.

The MRU mounting angles can either be input manually or determined by use of the **Mounting Wizard**. To use the MRU Mounting Wizard, see separate section in this manual.

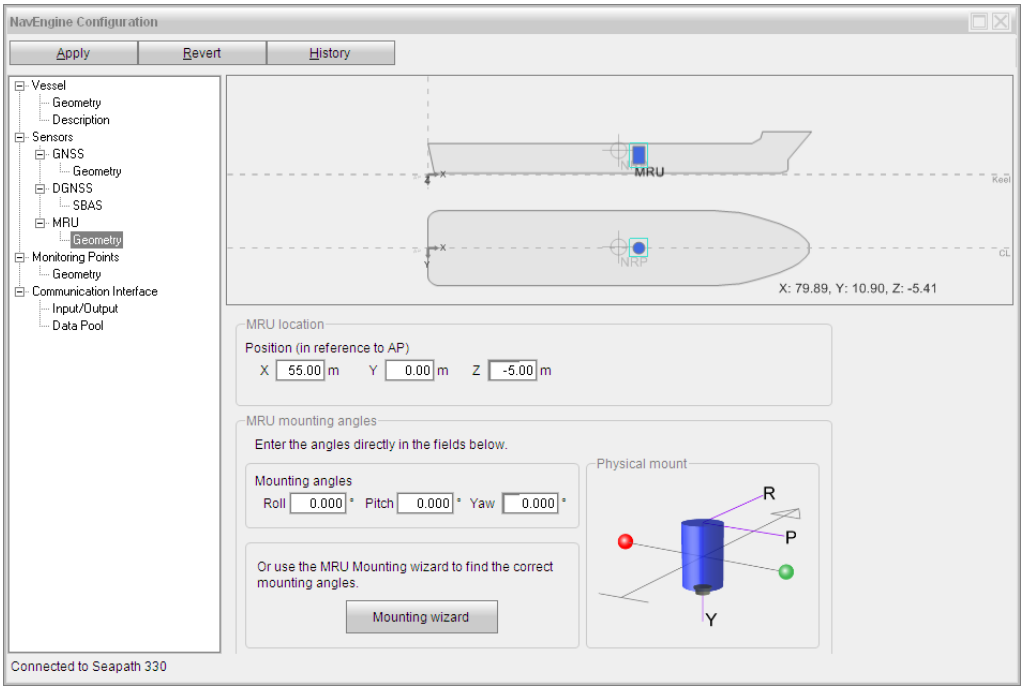


Figure 37 MRU geometry view

MRU location Enter the position of the MRU in X, Y, Z coordinated from AP. The MRU location has to be measured or calculated based upon drawings or previously measured points.

MRU mounting angles The mounting angles of the MRU in roll, pitch and yaw have to be input to the MRU. The MRU mounting wizard can be used to determine these mounting angles.

4.4.4.2 MRU mounting wizard

To use the **MRU Mounting Wizard** proceed as follows:

1 Press the **Mounting wizard** button in the MRU Geometry view.

2 Select Manual mode in Step 1 and click **Next**, see Figure 38.

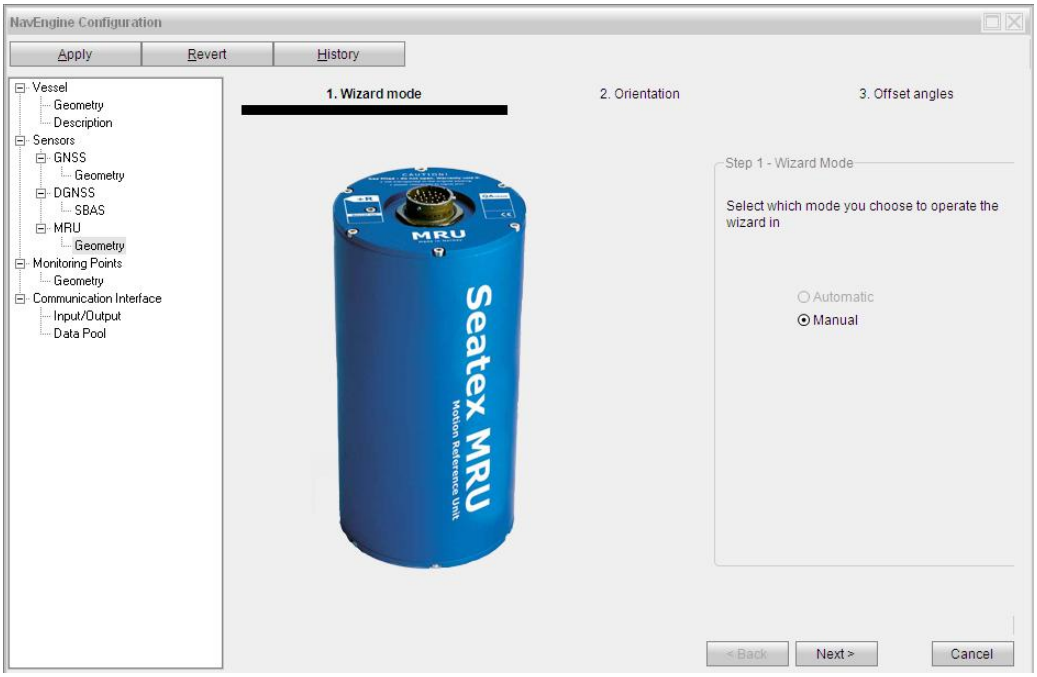


Figure 38 Step 1 of MRU axis orientation

3 Click the << or >> buttons in the lower left part of Figure 39 to turn the MRU unit around in 90-degree steps, axis by axis. Click until correct mounting orientation of the MRU has been found. The right part of this dialogue is automatically updated with the actual main rotation of the MRU. Click **Next** to proceed to Step 3.

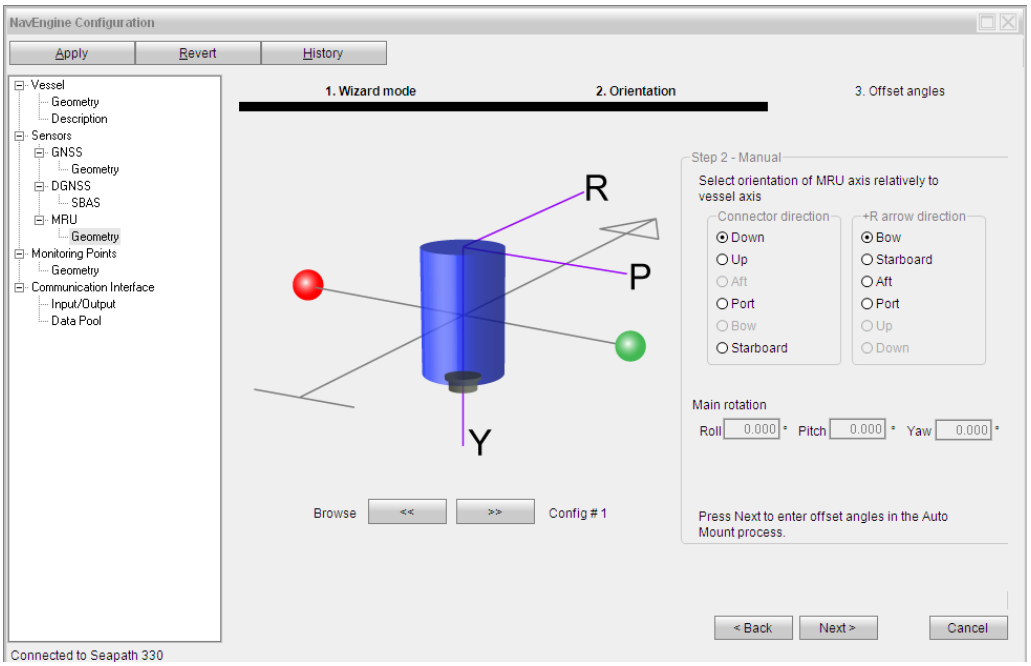


Figure 39 Step 2 of Manual input of mounting angles

4 At the top right of Figure 40 the main rotation angles of the MRU are displayed. Enter the offset angles for Roll, Pitch and Yaw from the main rotation angles. Press the **Help** button to get more help on the sign of the offset angles. A positive offset angle rotation is:

- Positive roll offset means starboard (right) side facing downward, or a clockwise rotation about the x-axis.
- Positive pitch offset means bow up, or a clockwise rotation about the y-axis.
- Positive yaw offset (heading, azimuth) means a turn to starboard (right), or a clockwise rotation about the z-axis.

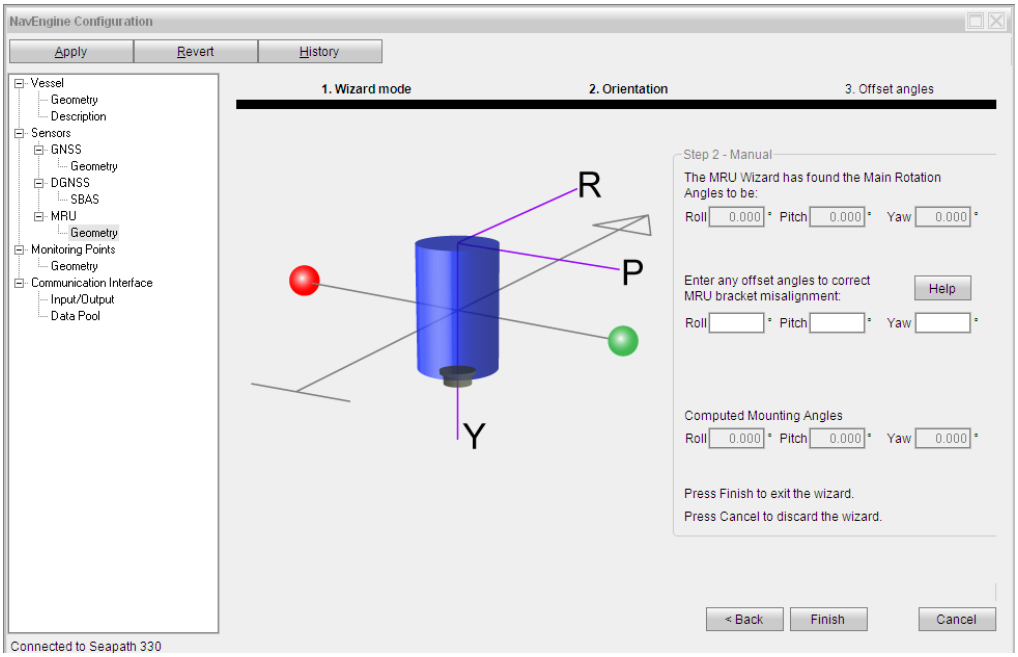


Figure 40 Step 3 of Manual input of MRU mounting angles

5 Press **Finish** to finish the manual setting of the MRU axis.

Note *The new MRU mounting angles are only valid in this system after pressing the **Apply** button.*

4.4.4.3 Heave configuration

When using real-time heave measurements, it is important to tune the heave parameters (heave period and damping) to the vessel size and the motion characteristics for the actual weather conditions. The default settings for filter mode heave period and damping, have to be tuned for the actual vessel and weather conditions in order to achieve optimum heave performance. Therefore, before a survey and/or during operation check the heave performance of the Seapath and tune the heave parameters until the best heave performance is achieved. An alternative is to select Automatic and let Seapath automatically choose the best settings. The following should be considered when selecting the different heave filter modes and parameters:

Filter mode:

- **Automatic**. To be selected when the vessel is operating in various sea states or when the average heave period is unknown.
- **General purpose**. Is selected when an optimal heave amplitude is to be measured and the heave phase is of no importance. This mode is typically selected when the Seapath is to be used for measuring the heave height and period on oceanographic buoys.
- **Hydrographic survey**. To be selected when the heave phase and amplitude have to be output correct in real time. This mode is typically selected when the heave output signal from the Seapath is to be used for heave compensation of echo sounders and offshore crane systems.

Period:

- An expected average heave period has to be set to the heave filter. This period can be determined by measuring the time between two wave-tops by using a watch.
- The settling time for the heave measurements from power-on or after a turn will be about 10 times the selected period, T_o. By selecting an unnecessary long heave period, the settling time will be slower than it has to. For vessels performing surveys with frequent turns, the period should be set as low as possible to minimise the heave settling time after turns.

Damping:

- The heave damping factor is usually set to 0.7. Only for special occasions should this parameter be changed. In operations with heave periods of more than 25 seconds, the damping factor should be reduced to 0.6 in order to achieve correct phase measurements. In operations with heave periods of less than 2 seconds, the damping factor should be increased to 0.8.

→ *For more details on selection of heave filter mode and parameters, see the User Manual.*

In order to select the heave configuration proceed as follows:

- Enter the settings for heave filter in the **MRU Heave config** dialogue. The pull-down Option menu has the following options; Integrated, Automatic, Hydrographic survey or General purpose. In Integrated, Hydrographic survey and General purpose mode, the filter parameter for Period can be set to a value between 1 and 25 seconds, and the Damping value between 0.2 and 1.

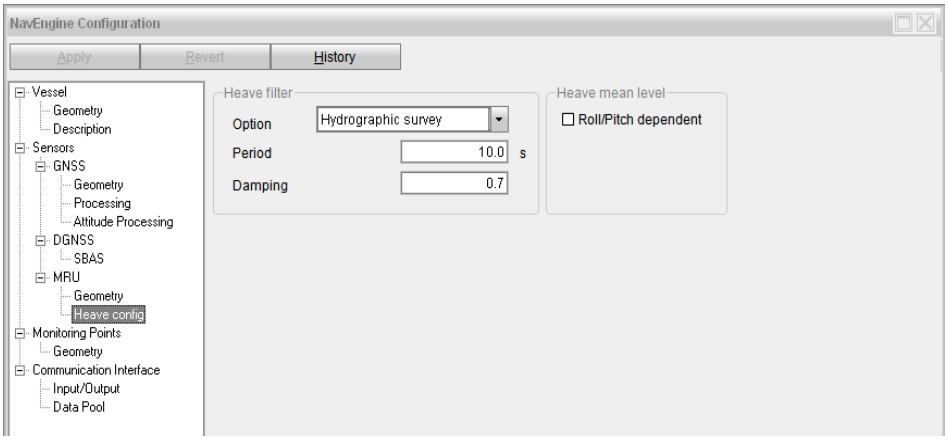


Figure 41 Heave filter view

- Click on the checkbox **Roll/Pitch dependent** in the Heave mean level section to make the heave measurement dependent on the roll and pitch measurements. Then the heave position in the monitoring points (MP) now longer has zero mean level, instead its value depends on the vessel tilt at any time. This option is useful especially in applications where the distance between the MP and the sea level is to be determined, like in echo sounder installations with depth changes due to changes in vessel trim and list. If this mode is not selected, the heave will always have zero mean level.

4.4.5 Monitoring points

Enter the **Monitoring Point** configuration dialogue to configure monitoring points for output of data. Up to 8 monitoring points may be defined. As the monitoring points are inserted, they are displayed graphically. The monitoring points are given relative to the AP.

Check that the monitoring points have been located on the expected points in the vessel shape. If not, check the signs and the co-ordinates input for each monitoring point, the vessel dimensions and the entered location of AP.

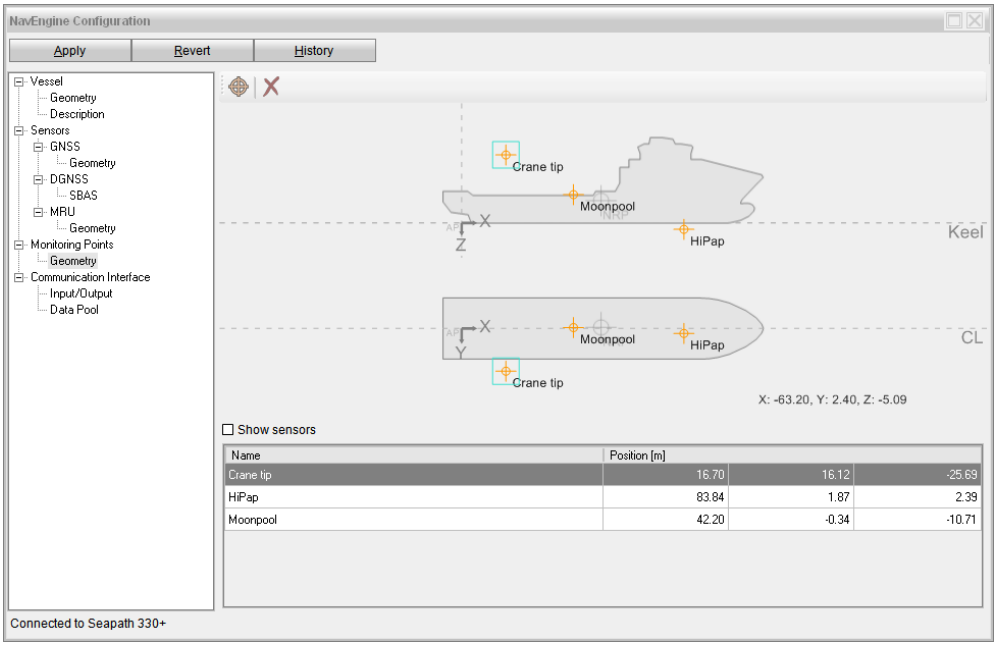


Figure 42 Monitoring points view

To add a monitoring point, select the **Add** icon in the upper left corner of the view and drag the symbol to the correct location on the vessel. The selected monitoring point coordinates are shown at the bottom of the view.

To get exact coordinates from AP to each monitoring point, each monitoring point has to be measured or calculated based upon drawings or previously measured points, and entered into the software manually. To delete a point, select the cross.

Note *If data shall be valid for NRP, it is not necessary to define a zero vector since the data is default output in NRP.*

When the **Add** icon is selected, red lines will be displayed on the screen to help placing the new point. Co-ordinates will also be displayed to help placing the monitoring point. The position and name of the added point may also be adjusted by writing the co-ordinates into the table below the vessel drawing.

Figure 43 illustrates adding a new new monitoring point by clicking on the cross symbol and draging the mouse and cross to the correct location.

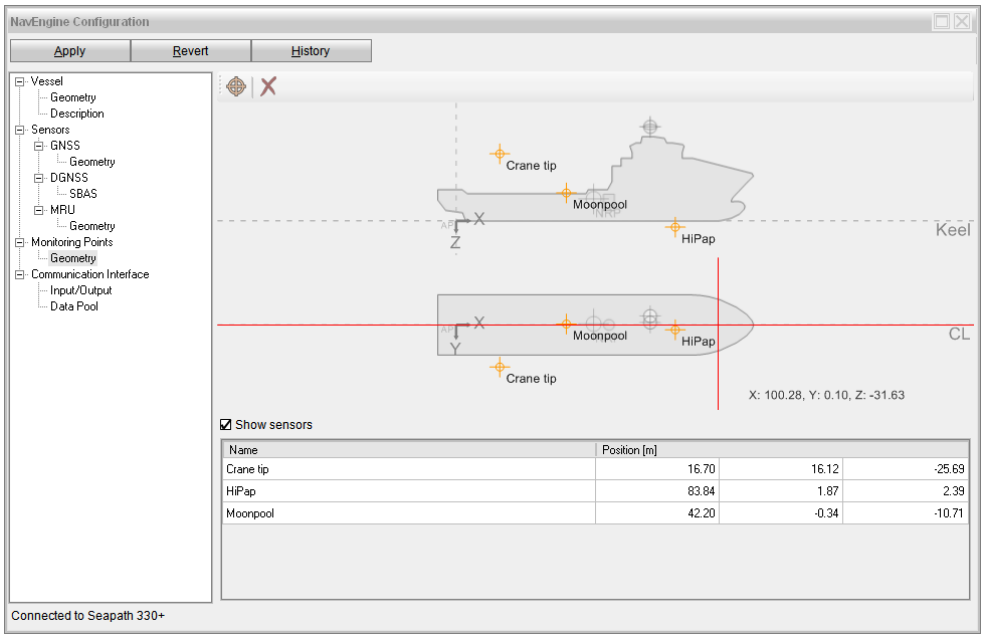


Figure 43 Add a new monitoring point

Figure 44 illustrates that a new monitoring point, MP4, has been added to the list of monitoring points.

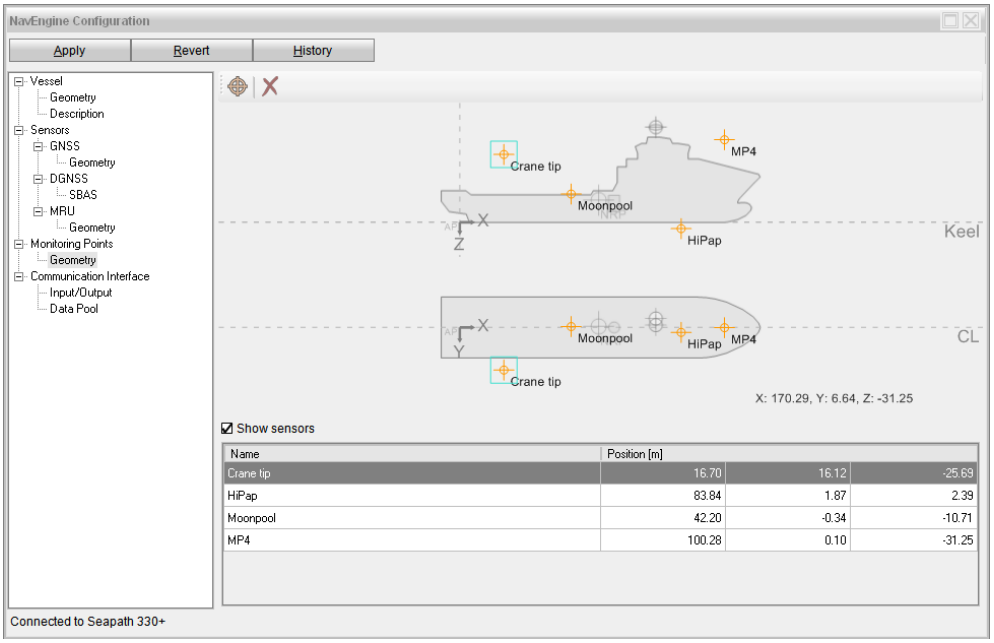


Figure 44 New monitoring point, MP4, added to list

Figure 45 illustrates renaming of a monitoring point to a preferred name, here from MP4 to Helideck.

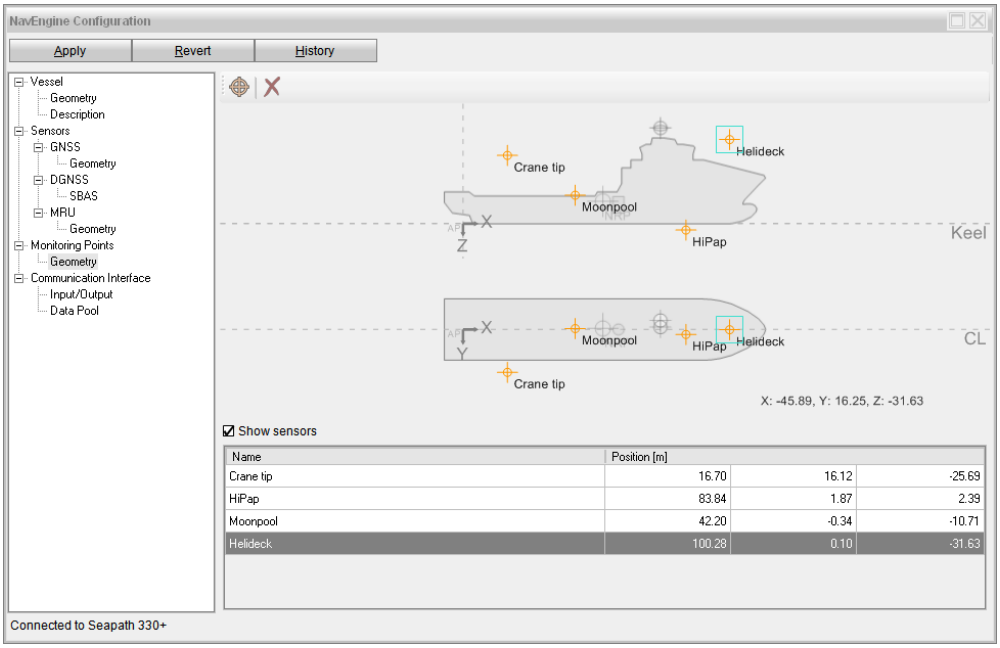


Figure 45 Renaming of monitoring point to preferred name

4.4.6 Communication interface

4.4.6.1 Input/Output

The figure below displays a default view for the Input/Output communication before any interface details are added.

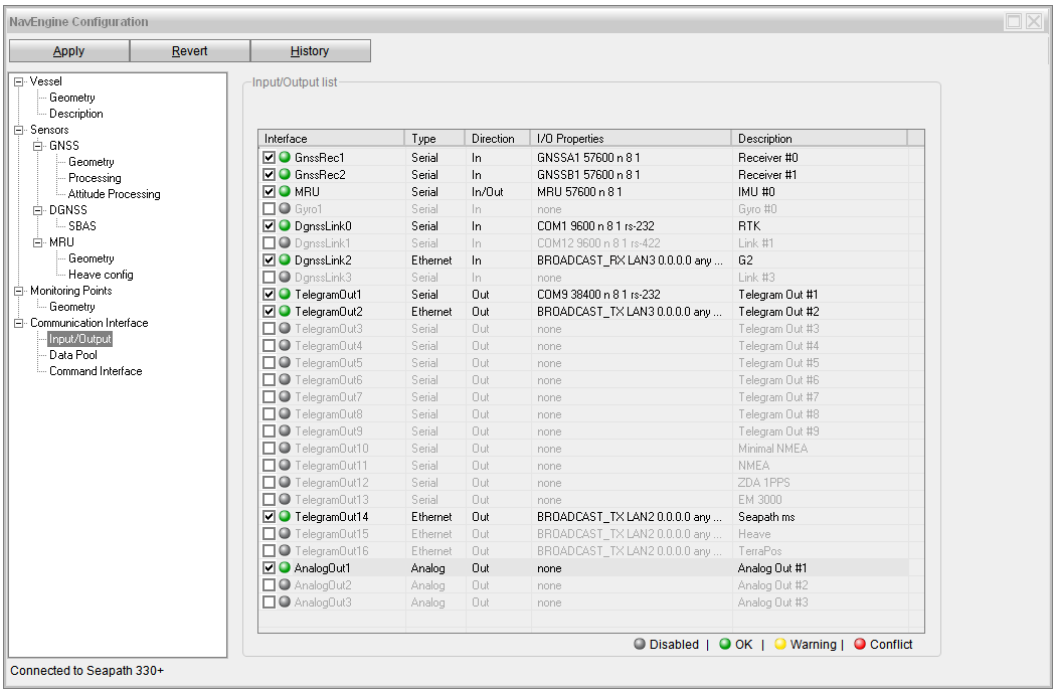

NavEngine Configuration
Apply
Revert
History
Vessel
Geometry
Description
Sensors
GNSS
Geometry
Processing
Attitude Processing
DGNSS
SBAS
MRU
Geometry
Heave config
Monitoring Points
Geometry
Communication Interface
Input/Output
Data Pool
Command Interface
Input/Output list
Interface
Type
Direction
I/O Properties
Description
GnssRec1 Serial In GNSSA1 57600 n 8 1 Receiver #0
GnssRec2 Serial In GNSSB1 57600 n 8 1 Receiver #1
MRU Serial In/Out MRU 57600 n 8 1 IMU #0
Gyro1 Serial In none Gyro #0
DgnssLink0 Serial In COM1 9600 n 8 1 rs-232 RTK
DgnssLink1 Serial In COM12 9600 n 8 1 rs-422 Link #1
DgnssLink2 Ethernet In BROADCAST_RX LAN3 0.0.0.0 any ... G2
DgnssLink3 Serial In none Link #3
TelegramOut1 Serial Out COM9 38400 n 8 1 rs-232 Telegram Out #1
TelegramOut2 Ethernet Out BROADCAST_TX LAN3 0.0.0.0 any ... Telegram Out #2
TelegramOut3 Serial Out none Telegram Out #3
TelegramOut4 Serial Out none Telegram Out #4
TelegramOut5 Serial Out none Telegram Out #5
TelegramOut6 Serial Out none Telegram Out #6
TelegramOut7 Serial Out none Telegram Out #7
TelegramOut8 Serial Out none Telegram Out #8
TelegramOut9 Serial Out none Telegram Out #9
TelegramOut10 Serial Out none Minimal NMEA
TelegramOut11 Serial Out none NMEA
TelegramOut12 Serial Out none ZDA 1PPS
TelegramOut13 Serial Out none EM 3000
TelegramOut14 Ethernet Out BROADCAST_TX LAN2 0.0.0.0 any ... Seapath ms
TelegramOut15 Ethernet Out BROADCAST_TX LAN2 0.0.0.0 any ... Heave
TelegramOut16 Ethernet Out BROADCAST_TX LAN2 0.0.0.0 any ... TerraPos
AnalogOut1 Analog Out none Analog Out #1
AnalogOut2 Analog Out none Analog Out #2
AnalogOut3 Analog Out none Analog Out #3
Disabled | OK | Warning | Conflict
Connected to Seapath 330+

Figure 46 Input/output view before interface details are added

When selecting an interface, the Input/Output view will be divided into two sections. The upper part consists of the list with all interfaces.

The lower part consists of **Configuration details** for the interface selected in the list. The configuration details vary between the different interfaces.

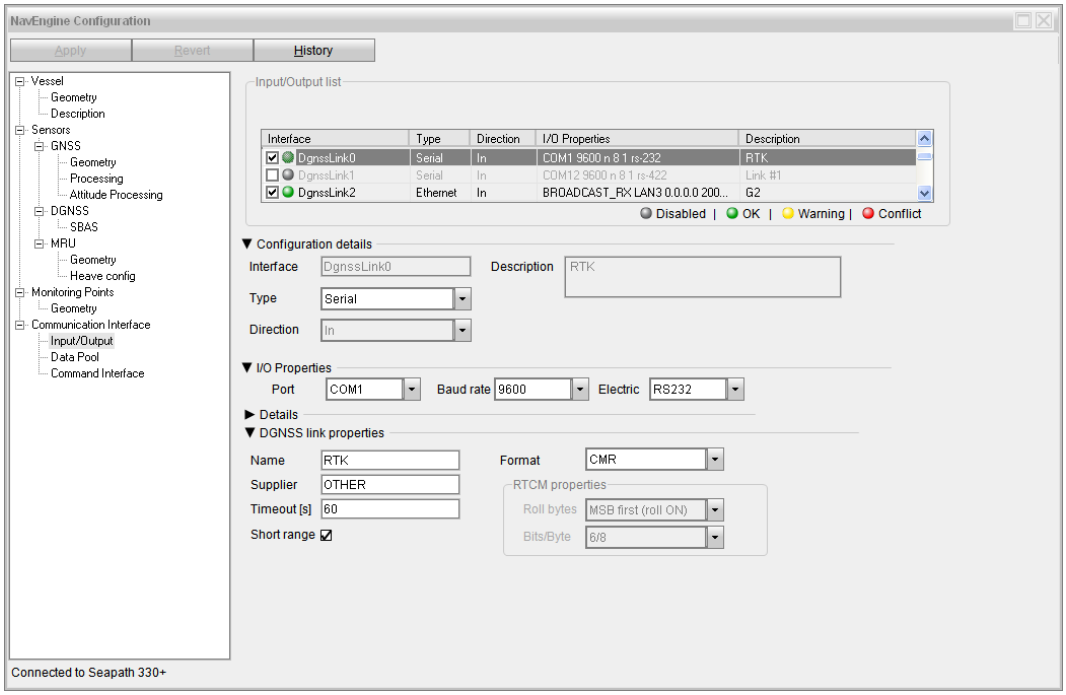


Figure 47 Input/Output list view with configuration details

4.4.6.2 Configuration details

The Configuration details view is the lower part of the Input/Output list view. The Configuration details view is divided into two sections: an interface selection section and an I/O Properties section.

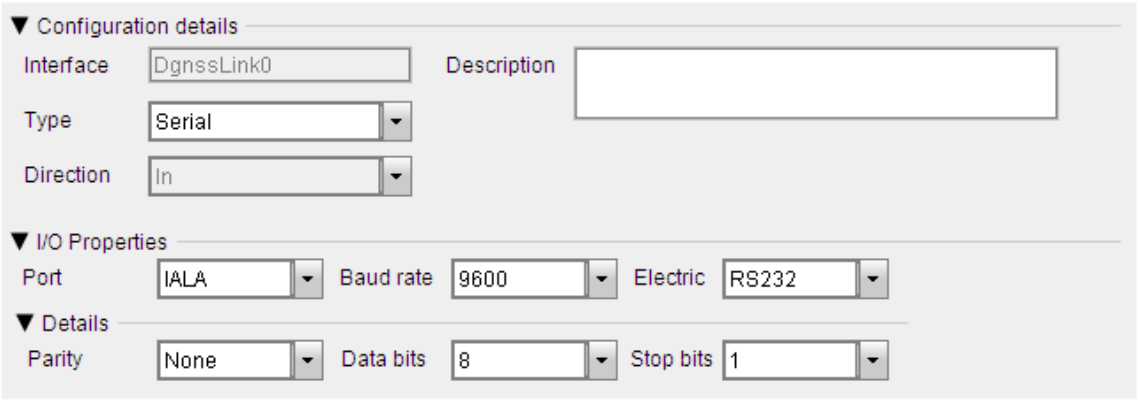


Figure 48 Configuration details view

The **Interfaces** possible to be setup for Seapath are:

- Gyro
- DGNSS link

- Telegram out
- Analog out

The different **Types** of interfaces possible are:

- Serial
- Net

The **Direction** which may be set up is In, Out and In/Out. In the **Description** box it is possible to enter free text.

4.4.6.3 I/O properties

The parameters displayed in the I/O properties views are dependent on what **Type** of interface is selected in the Configuration details sections.

4.4.6.3.1 Serial interface

The default view for the serial port interface is as shown in Figure 49.

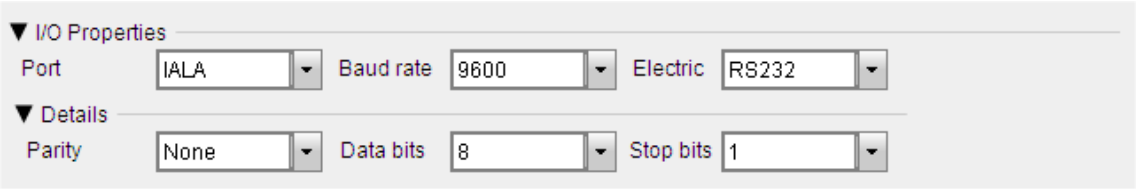


Figure 49 I/O properties view when serial interface is selected

The I/O Properties view when **Serial** interface is selected, contains the following parameters:

Port	Serial port number. Corresponds to the number at the rear of the Processing Unit.
Baud rate	Up to 115 200 bites/second.
Electric	RS-232 or RS-422.

Under the collapsible **Details** group box, less used properties are placed:

Parity	None, Odd or Even.
Data bits	6, 7 or 8.
Stop bits	1 or 2.

4.4.6.3.2 Ethernet interface

The network parameters section specifies how the Processing Unit communicates via the IP network.

The default view for the net interface properties is shown in Figure 50 below.

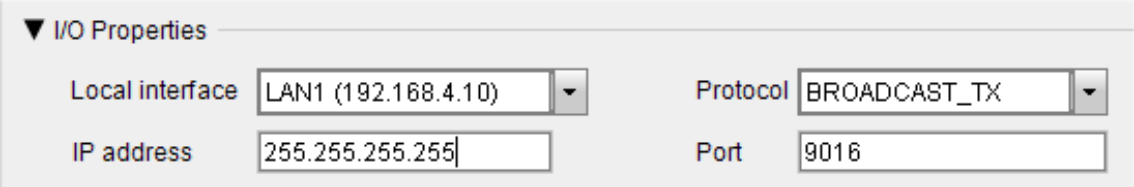


Figure 50 I/O properties view when net interface is selected

The I/O Properties view when Net interface is selected contains the following parameters:

Local interface The LAN port on the Processing Unit.

IP address The target IP address.

Protocol The UDP protocol. Options are Broadcast_TX, Multicast_TX or Unicast.

Port The number of the port to which the client listens.

4.4.6.4 Telegram out properties

When the Interface selected is set to TelegramOut, the Telegram out properties view is enabled at the bottom of the Configuration details view, see Figure 51.

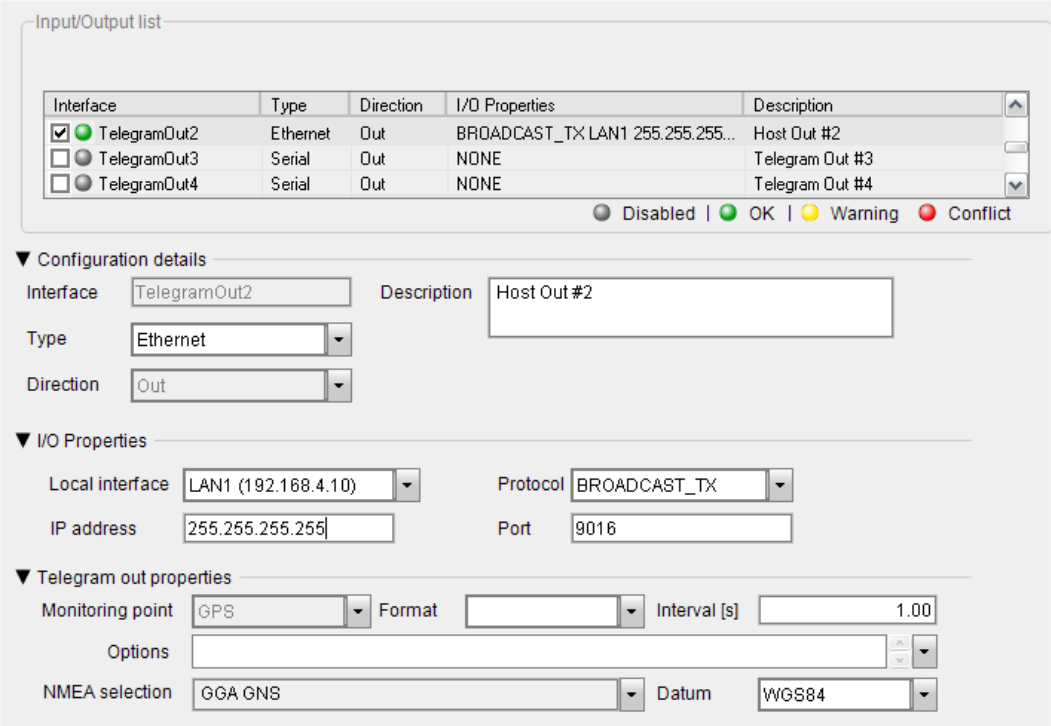


Figure 51 Interface set to TelegramOut

The main purpose of the output telegram function is to enable the configuration of data messages transmitted to external equipment. Up to 16 serial/network interfaces may be set up.

Monitoring point Select among the list of monitoring point and click on the MP the measurements are to be output in.

Format The format of the output telegrams. Select among the list of output formats.

Interval Seconds between messages being output.

Options From the Options drop down list, specific telegram outputs are set. The options are as described in Figure 52.

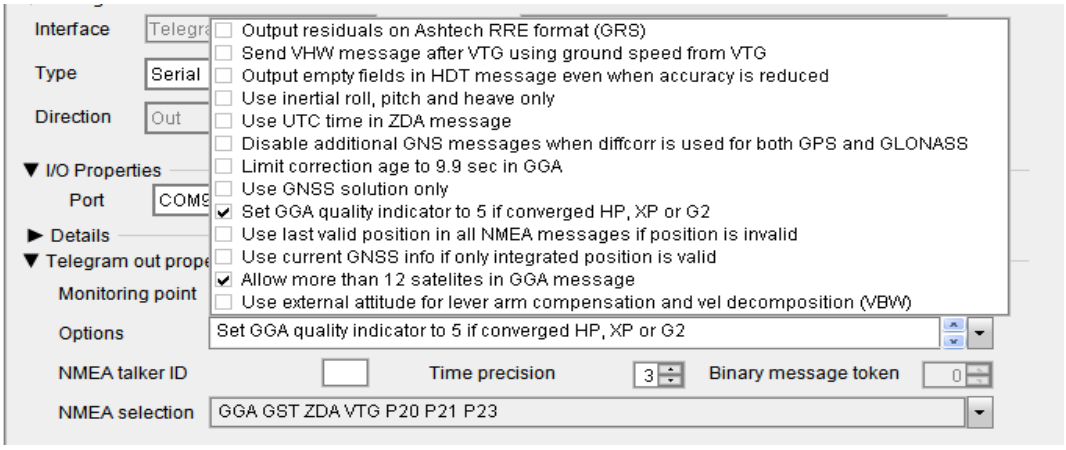

Interface
Type
Serial
Direction
Out
I/O Properties
Port
Details
Monitoring point
Options
NMEA talker ID
Time precision
3
Binary message token
0
NMEA selection
GGA GST ZDA VTG P20 P21 P23
Output residuals on Ashtech RRE format (GRS)
Send VHW message after VTG using ground speed from VTG
Output empty fields in HDT message even when accuracy is reduced
Use inertial roll, pitch and heave only
Use UTC time in ZDA message
Disable additional GNS messages when diffcorr is used for both GPS and GLONASS
Limit correction age to 9.9 sec in GGA
Use GNSS solution only
Set GGA quality indicator to 5 if converged HP, XP or G2
Use last valid position in all NMEA messages if position is invalid
Use current GNSS info if only integrated position is valid
Allow more than 12 satelites in GGA message
Use external attitude for lever arm compensation and vel decomposition (VBW)
Set GGA quality indicator to 5 if converged HP, XP or G2

Figure 52 Telegram output options

The telegram options are:

- Output residuals on Ashtech RRE format (GRS)
- Send VHW message after VTG using ground speed from VTG
- Output empty fields in HDT message even when accuracy is reduced
- Use inertial roll, pitch and heave only
- Use UTC time in ZDA message
- Disable additional GNS messages when diffcorr is used for both GPS and GLONASS
- Limit correction age to 9.9 seconds in GGA
- Use GNSS solution only
- Set GGA quality indicator to 5 if converged HP, XP or G2

- Use last valid position in all NMEA messages if position is invalid
- Allow more than 12 satellites in GGA message
- Use external attitude for lever arm compensation and vel decomposition (VBW)

NMEA selection If the Format is set to NMEA, this option is enabled. From a dropdown list, the following NMEA telegrams can be selected: DTM, GBS, GGA, GLL, GNS, GRS, GSA GST, GSV, RMC, ZDA, VTG, VBW, P20, P21, P22, P23, P24, ROT, HDG, HDT, ALL.

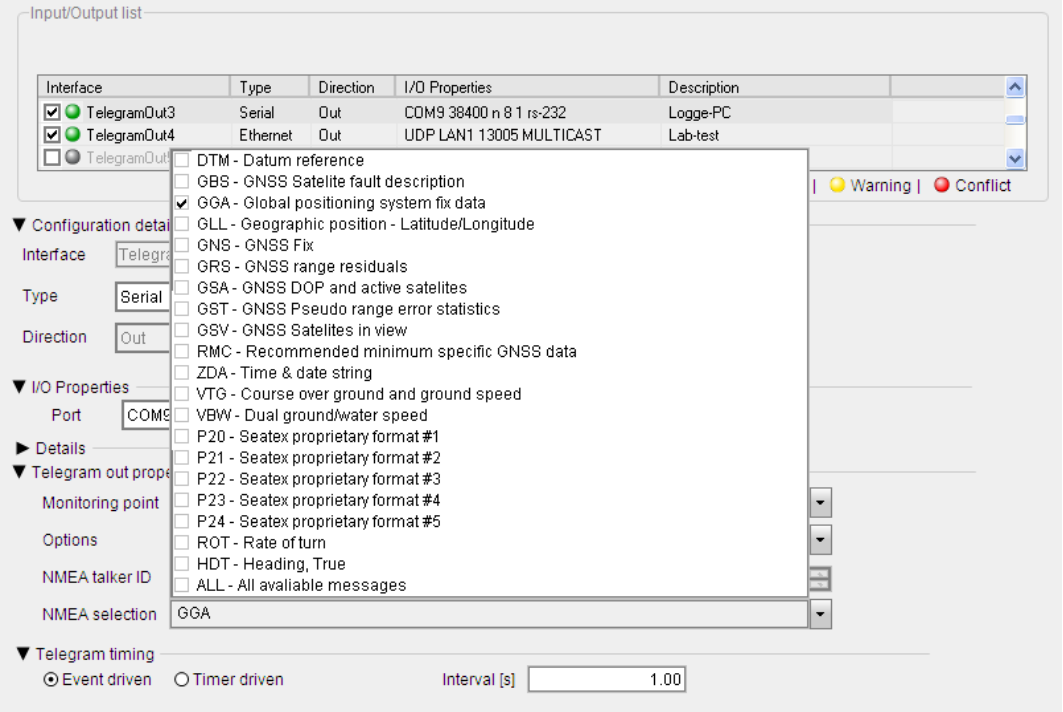


Figure 53 Available NMEA telegrams

Datum It is possible to set the following datum: ED 50, WGS 84 or NAD 27.

Type Event driven or Timer driven. When Timer driven is selected, the output interval between the telegrams can be decided.

4.4.6.5 Gyro properties

Heading from a gyrocompass or similar can be input to the Seapath as backup to improve reliability.

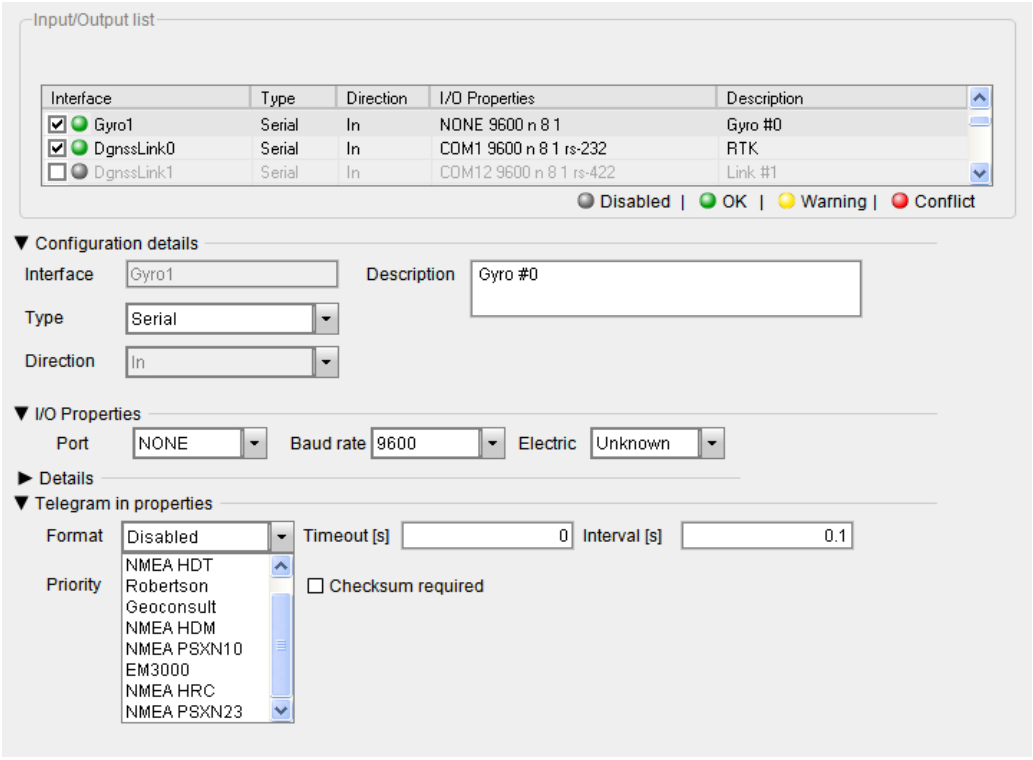


Figure 54 Gyro properties

Timeout Age limit. If the age of the gyro message exceeds this limit, the gyro message is invalid [s].

Format From the Format drop down list, the following options may be selected: Disabled, NMEA HDT, Robertson, Geoconsult, NMEA HDM, NMEA PSXN10, EM3000, NMEA HRC, NMEA PSXN23.

Priority Priority of the gyro interface. If more than one gyro interface is defined and available, one is selected for use, based on the priority specified.

Checksum required Enable or disabled. If disabled, no NMEA checksum is required.

4.4.6.6 Telegram timing

The selections and parameters displayed in the Telegram timing view are shown in Figure 51.

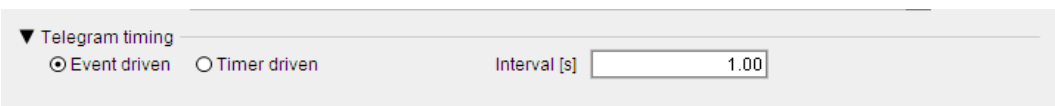


Figure 55 Telegram timing view

Event driven	Outputs data only when the data are calculated or when a change occurs. The output data are delayed when **Event driven** is selected.
Timer driven	Output data with the selected time interval, **Interval**.
Extrapolate	Extrapolates the time to real-time (zero-delay) when **Timing driven** output is selected.
Interval	The interval between each sample when **Timing driven** is selected. Can be selected in the range 0.005 to 300 seconds.

4.4.6.7 DGNSS link properties

It is possible to define several correction links. The links can be set up to decode RTCM, CMR, SeaSTAR HP/XP/G2 or AIS. Up to 8 DGNSS links may be set up.

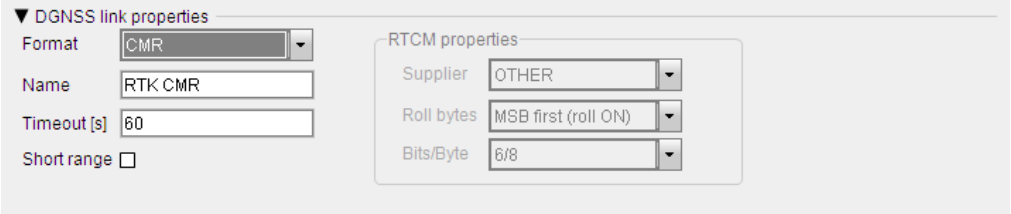


Figure 56 DGNSS link properties

Name	Name of the link displayed in the HMI.
Supplier	Name of the correction link supplier. May be Fugro, IALA, Petrobras, Topnav or other.
Timeout	Age limit. If the age of the correction exceeds this limit, the corrections are invalid [s].
Short range	Enable or disabled. If enabled, the stations received on this link are treated as near stations (distance=0).
Format	The following formats are available: RTCM, CMR, HP/XP/G2 and AIS.

If the Format is set to RTCM, two more settings are enabled.

Roll bytes	The following roll bytes are available: MSB first (RTCM standard) and LSB first.
Bits/Byte	The following bits/byte are available: 6 of 8 and 8 of 8.

4.4.6.8 Analog output

Three analog output channels are available from Seapath. For each of the channels the user must specify the following:

Monitoring point Select among the list of monitoring point and click on the MP in which the measurements are to be output.

Format The format of the output telegrams. Select among the list of output formats.

<Disabled>	Constant
Heave [m]	Heave velocity [m/s]
Mod.Roll [rad]	Pitch [rad]
Roll [rad]	sin(mod.roll) [-1 to 1]
sin(-pitch) [-1 to 1]	

Gain Set signal gain.

Offset Set signal offset.

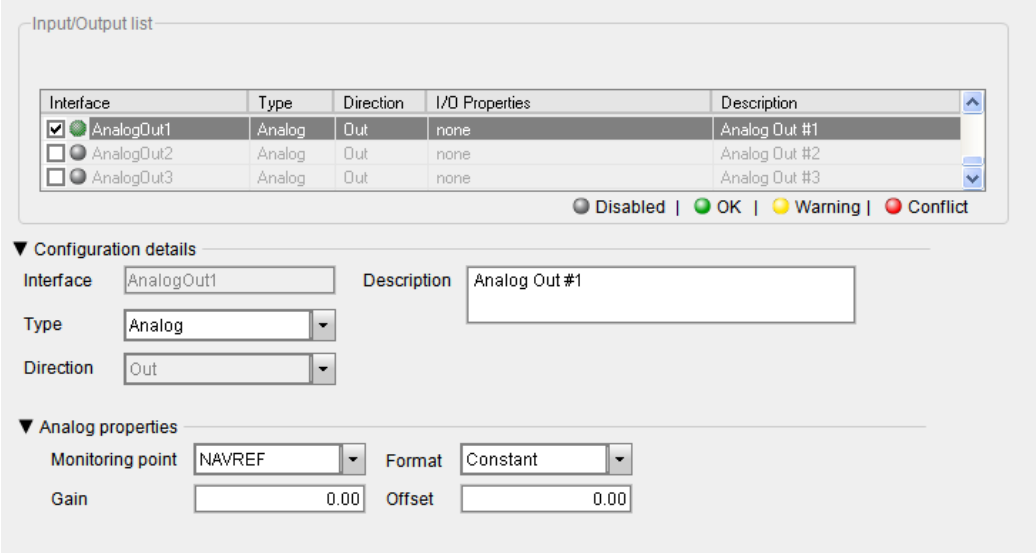


Figure 57 Analog output properties

Note *Negative gain and the value 1 have to be used for Heave in order to make the variables positive according to the Datawell co-ordinate system. The variable "sin(mod.roll)" is to be selected for roll and "sin(-pitch)" for pitch. Both variables to be selected with positive gain 10 in order to achieve analog Hippy roll and pitch output.*

The analog format Constant can be selected to test one of the analog channels.

4.4.7 Data pool

Data pool is the distribution media for data from the NavEngine software to the operator software.

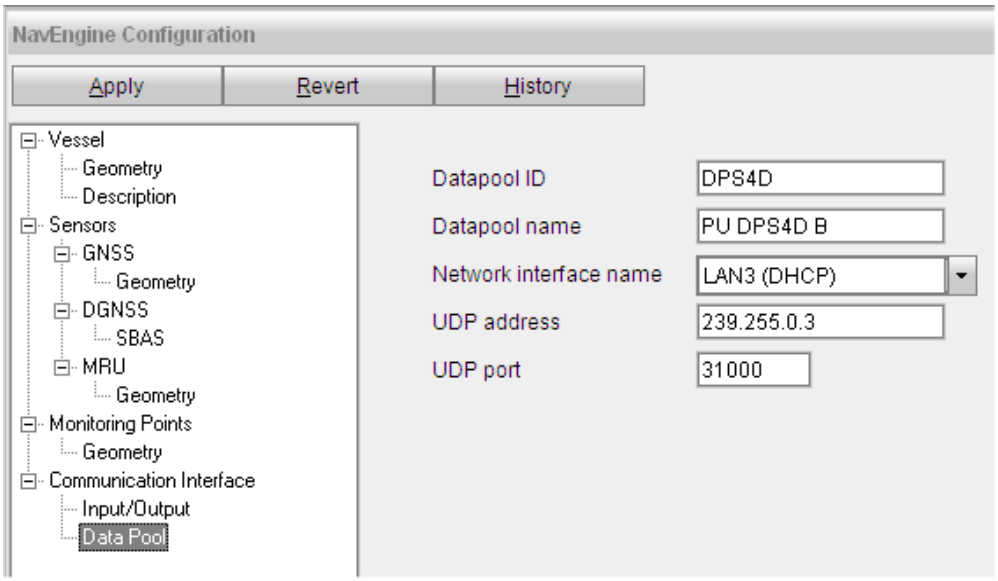


Figure 58 Data Pool configuration view

Datapool ID Identification ID. Own text may be inserted.

Datapool name Identification name. Own text may be inserted

Network interface name The LAN port on the Processing Unit.

UDP address The address the NavEngine should send data to.

UDP port The port the NavEngine should send data to**.**

Note *If the NavEngine should send data to the Operator software, the UDP address and UDP port must match the Address and Port entered in the Data Source tab in the Operator software configuration.*

4.5 Configuration backup

The **Tools|Copy Configuration** will launch a tool that copies all relevant configuration information to an archive file compatible with e.g. WinZip. The configuration is copied into the indicated archive name.

As with the System Verification tool, the Configuration Copier will create the archive in a hard disk folder or on an inserted USB memory stick if available.

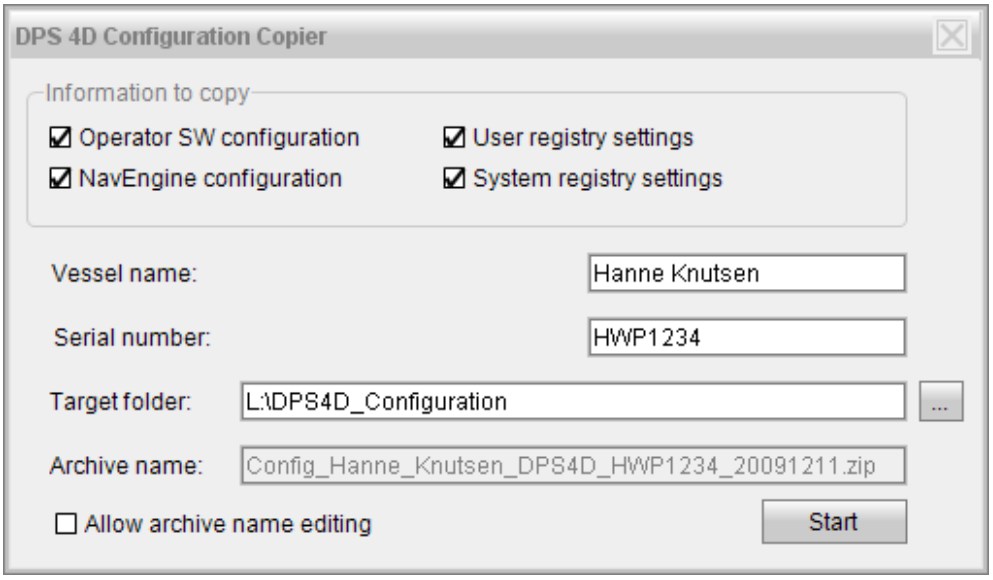


Figure 59 Configuration Copier

4.6 SRRD update

When the installation has been verified, we recommend performing an SRRD (Seatex Rescue and Restore Disk) update. An SRRD USB stick is delivered with your system. The stick contains a full image of the installed HMI Unit.

Follow the procedure below:

1 Reboot the HMI Unit. Press **F8** repeatedly during the boot sequence.

2 In the menu that appears, select **Return to OS Choices menu** and press the **Enter** key.

3 Select **Seatex Rescue and Restore** and press **Enter**.

4 Enter "stx" as password.

5 Wait until the menu appears.

6 Plug in the USB stick delivered with the system.

7 Wait about 5 seconds and then select **Refresh** menu.

8 The menu choice **Create a System Rescue and Restore Disk** should now appear. If not, repeat the above step.

9 Choose **Create a System Rescue and Restore Disk.**

10 Confirm that it is OK to delete everything on the target stick.

11 The SRRD creation will take 5 to 30 minutes or more, depending on the speed of the USB disk.

12 As soon as the completion message appears, return to the menu.

13 Select **Shut down**. When the message *System halted* appears, you should remove the USB stick and press the **Ctrl+Alt+Delete** keys simultaneously to boot the system as normal.

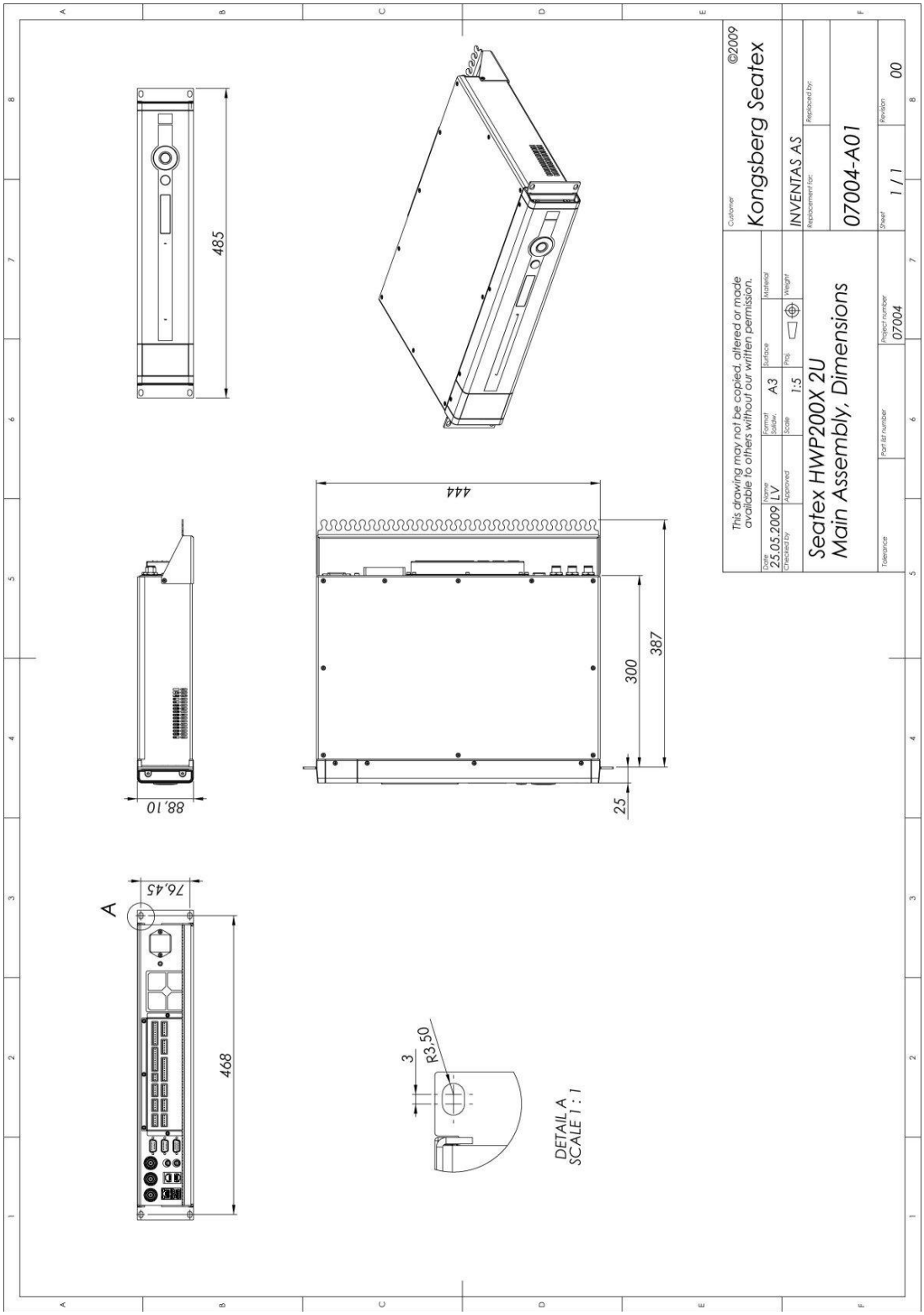
14 Store the SRRD in a safe place.

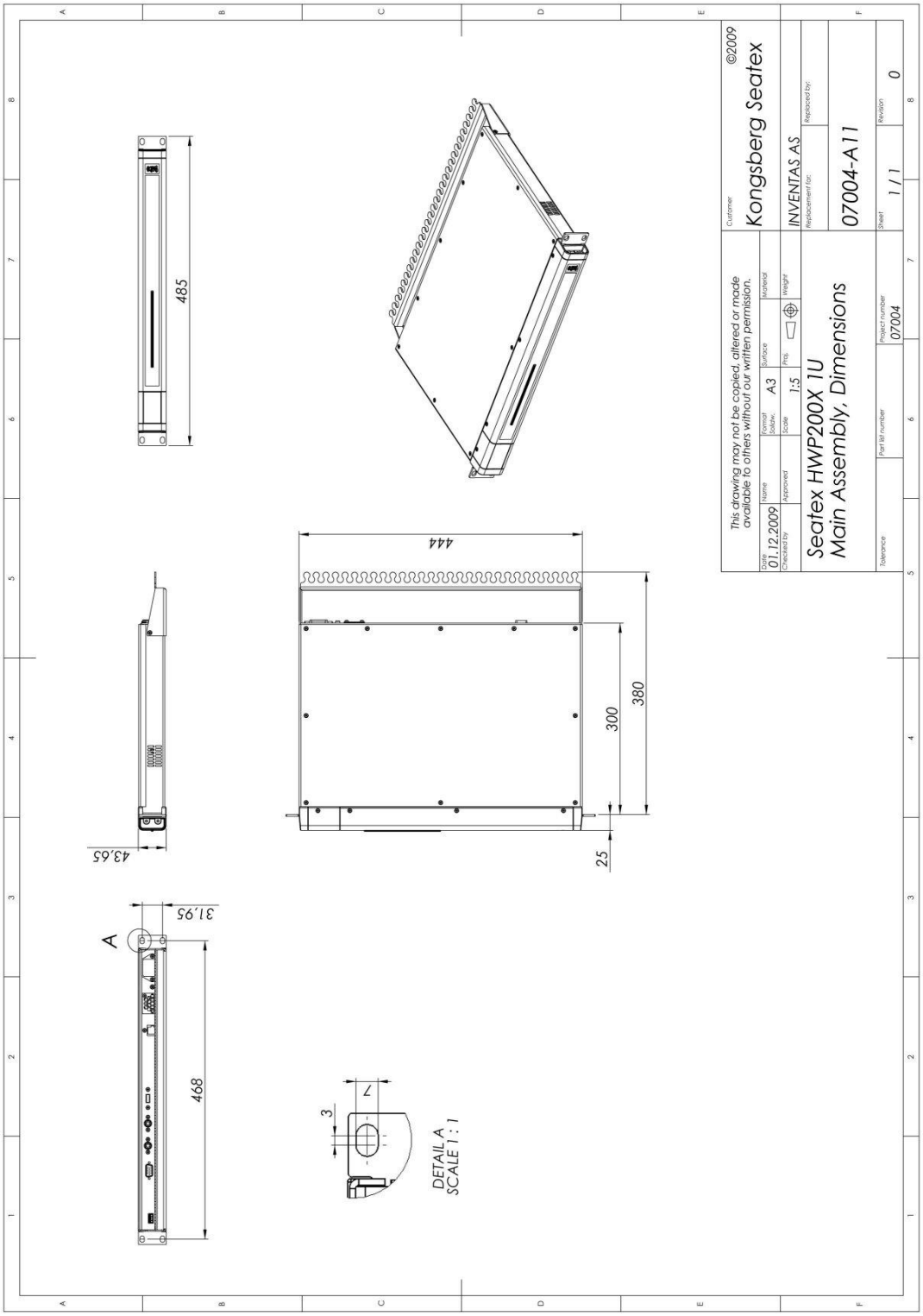
5 DRAWINGS

This section contains outline drawings, showing mechanical dimensions of the Processing and HMI Units, the GNSS Antenna Bracket and Holder, the MRU 5 and its mounting bracket, the MRU junction box, the GNSS antennas and the 6U cabinet.

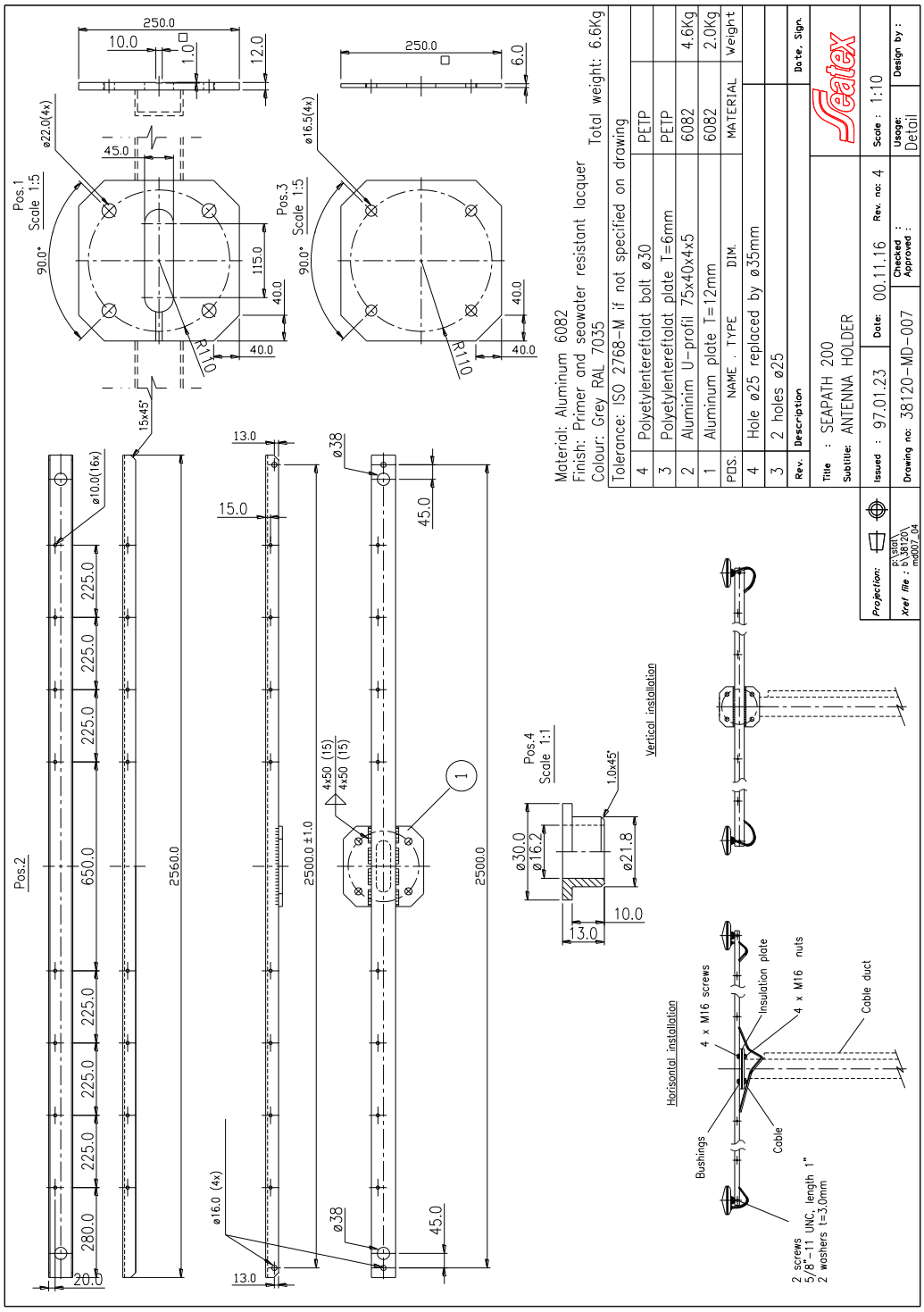
Note *The drawings are note to scale. To scale drawings are available on request.*

5.1 Processing and HMI Units

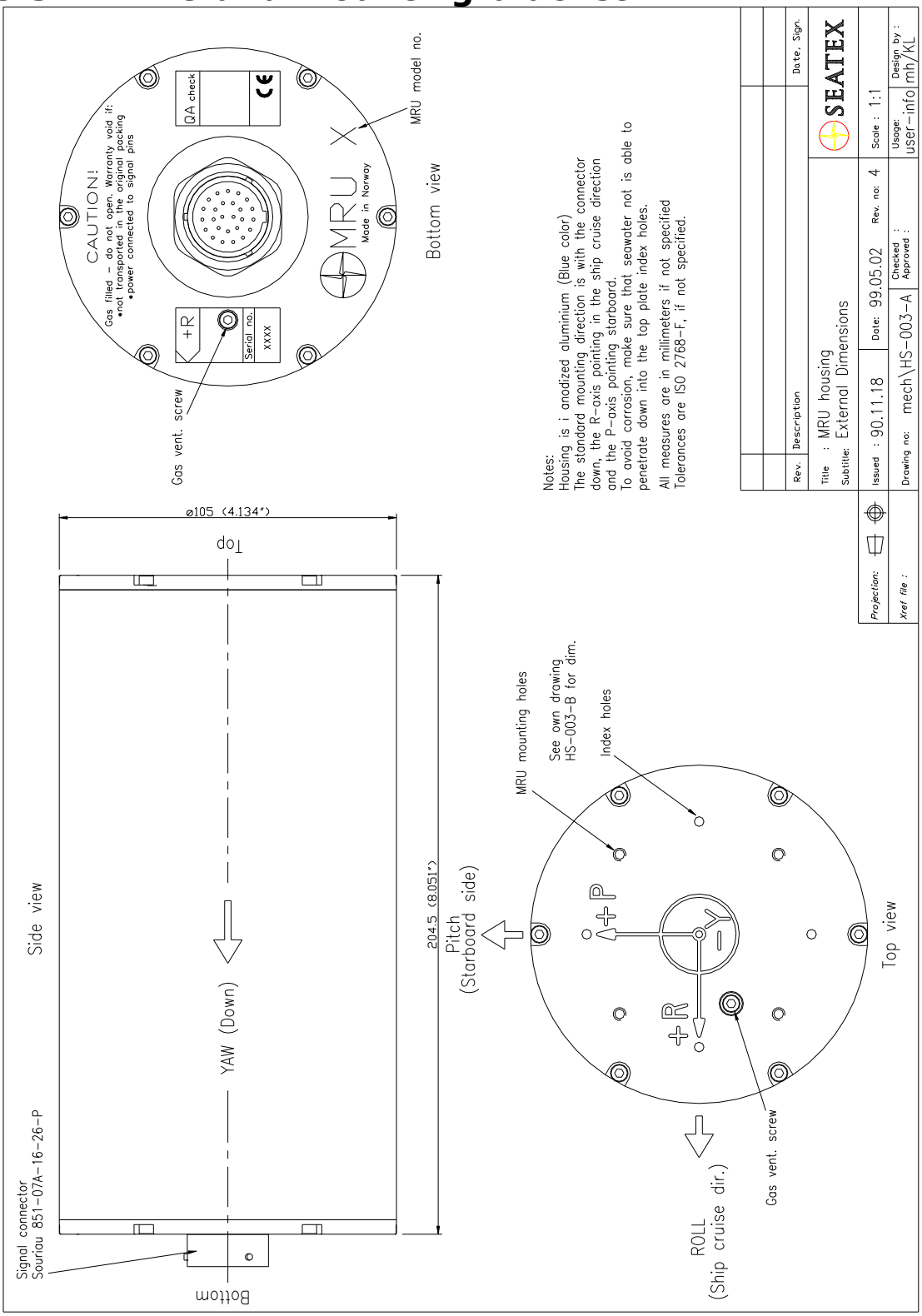


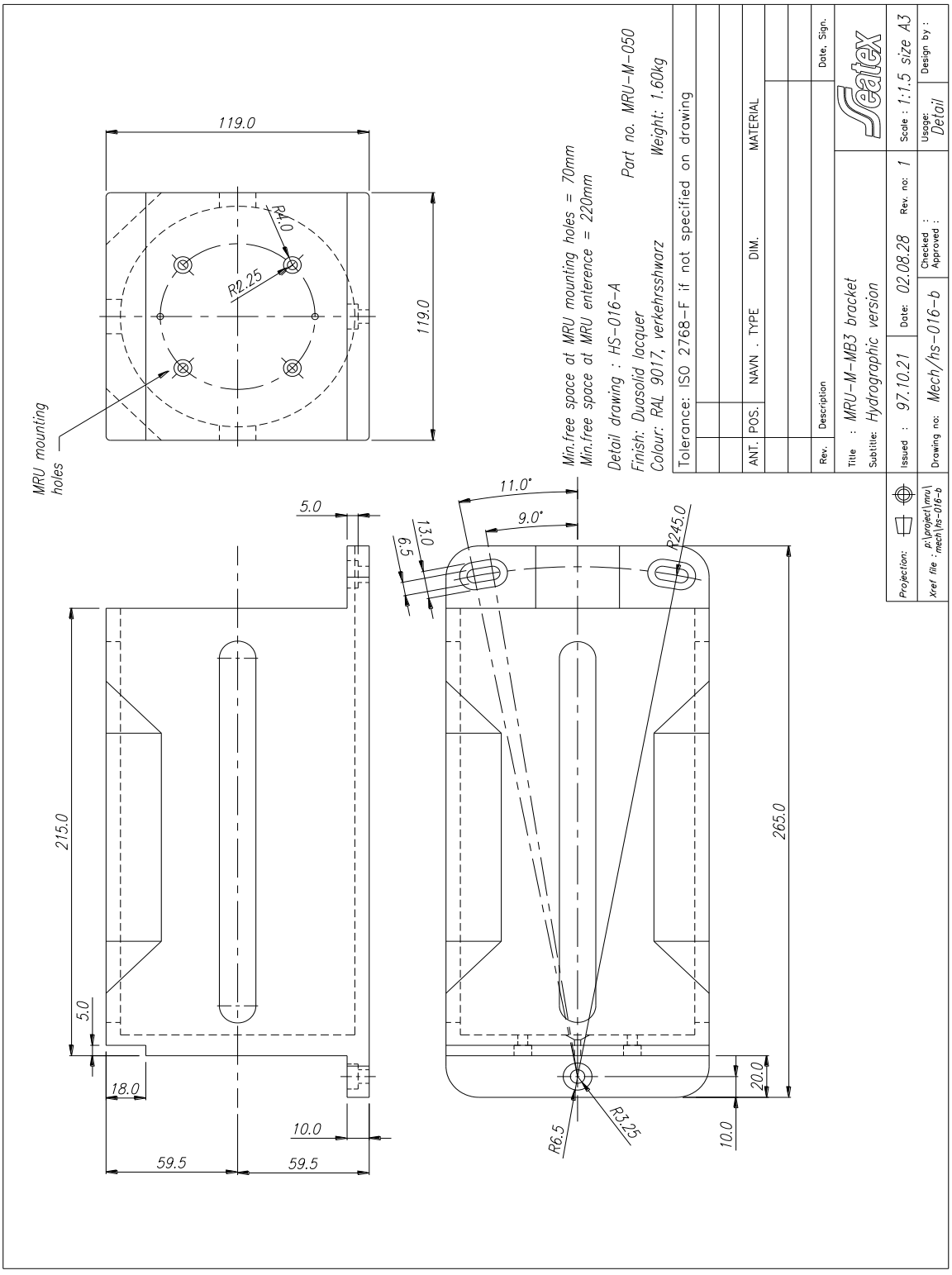

485
444
380
300
25
43,65
31,95
468
A
DETAIL A
SCALE 1 : 1
7
3
©2009
Kongsberg Seatex
INVENTAS AS
Seatex HWP200X 1U
Main Assembly, Dimensions
07004-A11
This drawing may not be copied, altered or made available to others without our written permission.

5.2 Antenna bracket

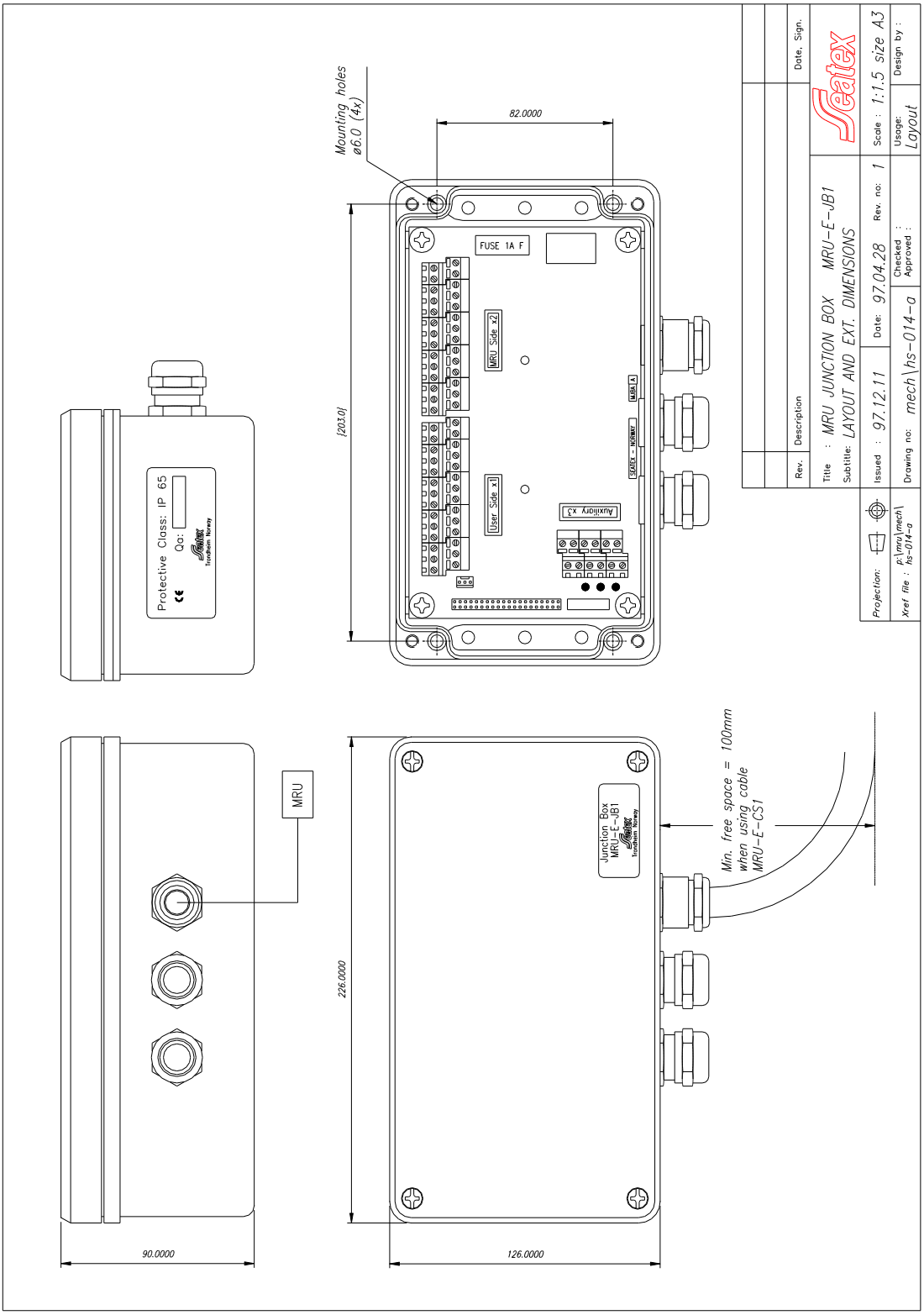

Material: Aluminum 6082
Finish: Primer and seawater resistant lacquer
Colour: Grey RAL 7035
Total weight: 6.6Kg
Tolerance: ISO 2768-M if not specified on drawing
4 Polyetylentereftalat bolt ø30 PETP
3 Polyetylentereftalat plate T=6mm PETP
2 Aluminim U-profil 75x40x4x5 6082 4.6Kg
1 Aluminum plate T=12mm 6082 2.0Kg
POS. NAME . TYPE DIM. MATERIAL Weight
4 Hole ø25 replaced by ø35mm
3 2 holes ø25
Rev. Description Date. Sign.
Title : SEAPATH 200
Subtitle: ANTENNA HOLDER
Issued : 97.01.23 Date: 00.11.16 Rev. no: 4 Scale : 1:10
Drawing no: 38120-MD-007 Checked : Approved : Usage: Detail Design by :
Projection:
Xref file : p:\stat\38120\mdl07_04
Pos.1 Scale 1:5
Pos.2
Pos.3 Scale 1:5
Pos.4 Scale 1:1
Vertical installation
Horisontal installation
4 x M16 screws
Insulation plate
4 x M16 nuts
Cable duct
Bushings
Cable
2 screws 5/8"-11 UNC, length 1"
2 washers t=3.0mm

5.3 MRU and mounting bracket

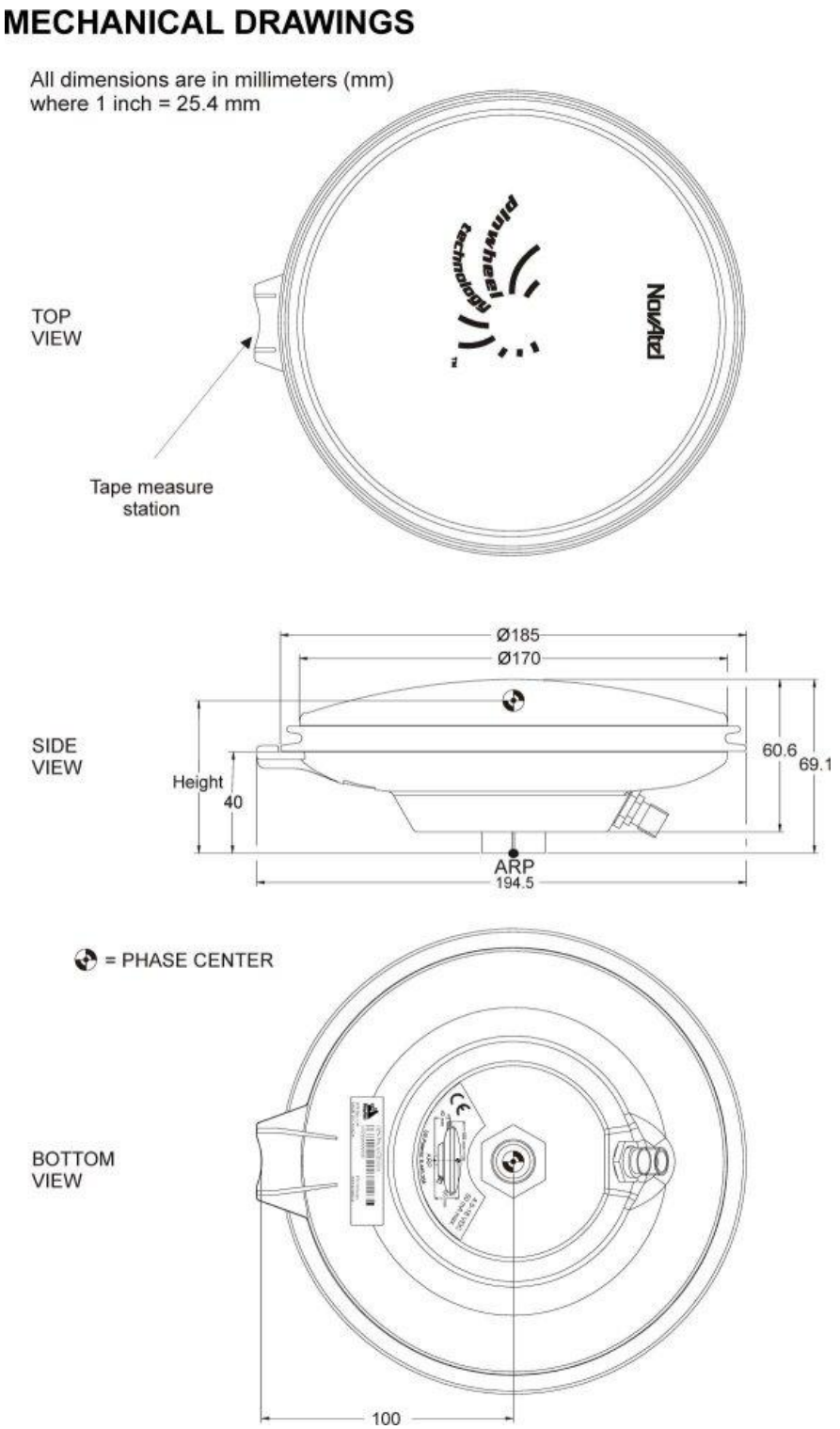



119.0
119.0
R4.0
R2.25
MRU mounting holes
Min.free space at MRU mounting holes = 70mm
Min.free space at MRU enterence = 220mm
Detail drawing : HS-016-A
Finish: Duosolid lacquer
Colour: RAL 9017, verkehrsshwarz
Part no. MRU-M-050
Weight: 1.60kg
Tolerance: ISO 2768-F if not specified on drawing
Rev. Description Date, Sign.
ANT. POS. NAVN : TYPE DIM. MATERIAL
Title : MRU-M-MB3 bracket
Subtitle: Hydrographic version
Seatex
Projection:
Issued : 97.10.21
Date: 02.08.28
Rev. no: 1
Scale : 1:1.5 size A3
Xref file : p:\projekt\mru\mech\hs-016-b
Drawing no: Mech/hs-016-b
Checked :
Approved :
Usage: Detail
Design by :
5.0
11.0°
9.0°
13.0
6.5
R245.0
215.0
265.0
5.0
18.0
10.0
59.5
59.5
20.0
10.0
R6.5
R325

5.4 MRU junction box

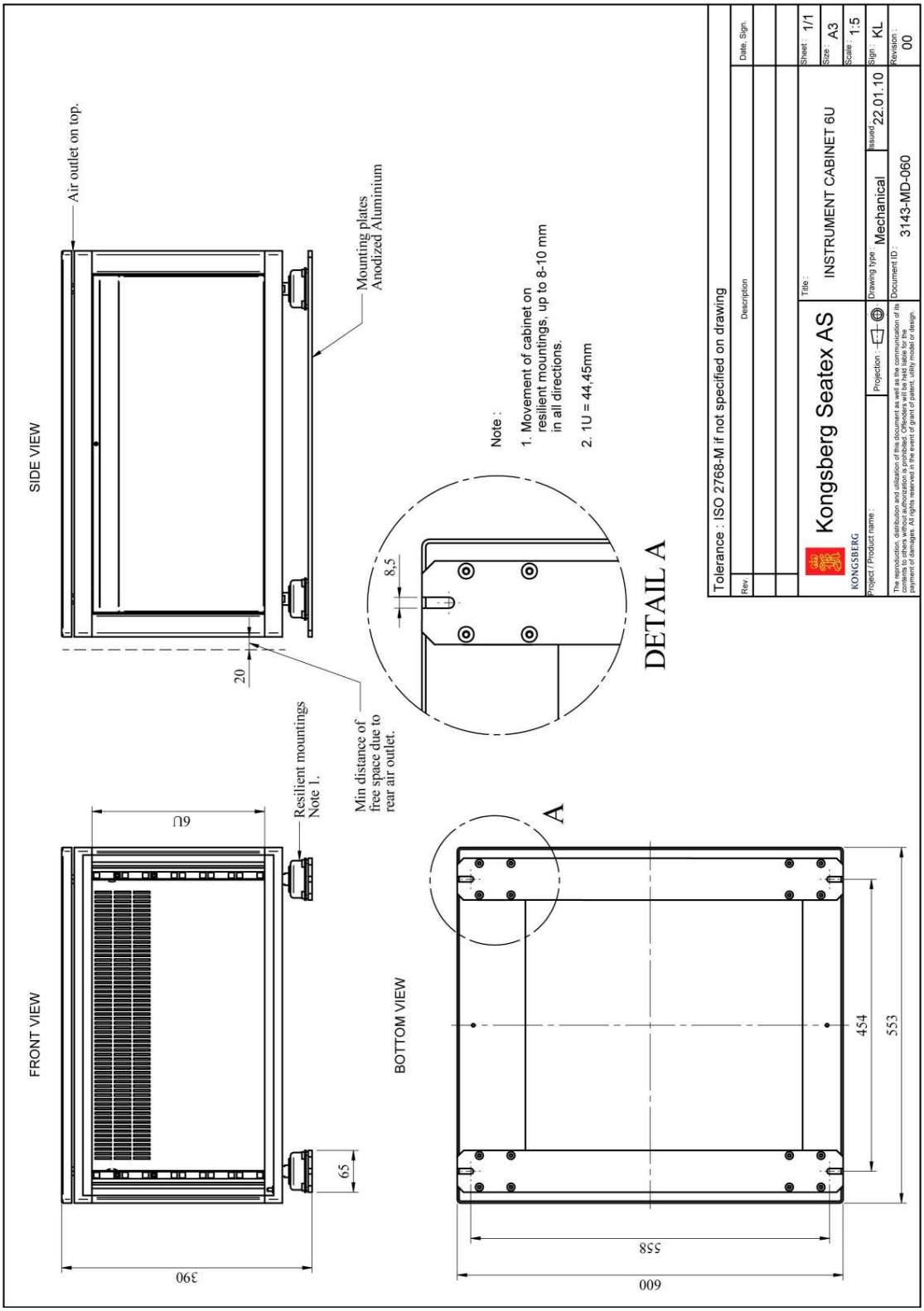


5.5 GNSS antenna mechanical drawings



Excerpt from GPS-702-GG, GPS-701-GG and GPS702-GG-N User Guide, OM-20000095, rev. 1B, August 7, 2009, NovAtel Inc.

5.6 6 U cabinet dimensions



APPENDIX A OUTPUT PROTOCOLS

The following output data protocols are available from Seapath:

Name	Format no.	Description
NMEA	1	NMEA and proprietary messages
Seapath binary fmt3	3	Seapath binary format 3
Simrad EM3000/Hipap	6	Simrad EM3000, 300 and Hipap compatible
Calibration	7	Calibration format for GPS antennas
Echo Sounder fmt9	9	Echo sounder format
RDI ADCP	10	RDI ADCP format, PRDID
Seapath binary 11 fmt11	11	Seapath binary format 11
Lehmkuhl gyro repeater	12	Lehmkuhl gyro repeater format
1PPS NMEA ZDA	13	1PPS time tag, NMEA ZDA message
1PPS Trimble	14	1PPS time tag, Trimble compatible message
Atlas Fansweep	16	Atlas Fansweep format
Echo Sounder fmt18	18	Echo sounder format, TSS1 compatible
Seapath binary 23	23	Seapath binary format 23
PFreeHeave format	24	Delayed heave format

A.1 NMEA format

The NMEA format is an ASCII text format using ZDA, GGA, GLL, VTG, HDT, GST, GSA and GRS messages defined in [1] and the proprietary PSXN 20, 21, 22 and 23 messages conforming to the same specification.

Format:

$INZDA,*time***,***day***,***month***,***year***,,*****csum term*

$INGGA,*time***,***lat***,{N|S},***long***,{E|W},***gga-qual***,***nsat***,***hdop***,***height***,M,,M,***age***,***stn*****csum term*

$INGLL,*lat***,{N|S},***long***,{E|W},***time***,***gll-qual***,***mode*****csum term*

$INVTG,*course***,T,,M,***speed***,N,,K,***mode*****csum term*

$INHDT,*head***,T*****csum term*

$INGST,*time***,,***semi-maj***,***semi-min***,***ell-orient***,***sd-lat***,***sd-long***,***sd-height*********csum term*

$INGSA,*gsa-mode***,***gsa-status***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***id***,***pdop***,***hdop***,***vdop*********csum term*

$INGRS,*time***,1,***res***,***res***,***res***,***res***,***res***,***res***,***res***,***res***,***res***,***res***,***res***,***res*********csum term*

$PSXN,20,*horiz-qual***,***hgt-qual***,***head-qual***,***rp-qual*********csum term*

$PSXN,22,*gyro-calib***,***gyro-offs*********csum term*

$PSXN,23,*roll***,***pitch***,***head***,***heave*********csum term*

$PSXN,24,*roll-rate***,***pitch-rate***,***yaw-rate***,***vertical-vel*********csum term*

$PSXN,21,*event*csum term*

Explanation:

time	UTC time on format hhmmss.ss where hh is hours (00 - 23), mm is minutes (00 - 59) and ss.ss is seconds (00.00 - 59.99).
day	Day of month (01 - 31).
month	Month of year (01 - 12).
year	Year on format yyyy.
lat	Latitude on format ddmm.mmmmmm where dd is degrees (00 - 90) and mm.mmmmmm is minutes (00.000000 - 59.999999).
long	Longitude on format dddmm.mmmmmm where ddd is degrees (000 - 180) and mm.mmmmmm is minutes (00.000000 - 59.999999).
gga-qual	GPS quality indicator: 0 = invalid position, 1 = GPS SPS used, 2 = DGPS used, 3 = GPS PPS used, 4 = GPS RTK used, 5 = GPS float RTK used, 6 = dead reckoning.
nsat	Number of satellites in use (00 - 99).
hdop	HDOP on format x.x.
height	Height above ellipsoid in metres on format m.mm.
age	Age of DGPS corrections in seconds on format s.s.
stn	DGPS reference station ID (0000 - 1023).
gll-qual	Geographic position quality: A = valid, (D)GPS used (normal or reduced performance), V = dead reckoning or invalid position.
mode	Positioning mode: A = GPS used, D = DGPS used, E = dead reckoning, N = invalid position/velocity.
course	Course over ground, degrees true on format d.dd (0.00 - 359.99).
speed	Speed over ground, knots on format k.k.

head	Heading, degrees true on format d.dd (0.00 - 359.99).
semi-maj	Standard deviation of the semi-major axis of the position error ellipse in metres on format m.mm.
semi-min	Standard deviation of the semi-minor axis of the position error ellipse in metres on format m.mm.
ell-orient	Orientation of the semi-major axis of the position error ellipse in degrees (0 - 180).
sd-lat	Standard deviation of latitude error in metres on format m.mm.
sd-long	Standard deviation of longitude error in metres on format m.mm.
sd-height	Standard deviation of height error in metres on format m.mm.
gsa-mode	GPS position mode setting: A = height aiding enabled, M = 3D only.
gsa-status	GPS position mode used: 1 = no GPS position, 2 = height aided (3 satellites), 3 = 3D.
id	Satellite ID number, PRN (01 – 32).
pdop	PDOP on format x.x
vdop	VDOP on format x.x.
res	GPS range residual in metres on format m.m (no fraction if the value is greater than 99.9 metres).
horiz-qual	Horizontal position and velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data.
hgt-qual	Height and vertical velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data.
head-qual	Heading quality: 0 = normal, 1 = reduced performance, 2 = invalid data.
rp-qual	Roll and pitch quality: 0 = normal, 1 = reduced performance, 2 = invalid data.
gyro-calib	Gyro calibration value since system start-up in degrees on format d.dd.
gyro-offs	Short-term gyro offset in degrees on format d.dd.
roll	Roll in degrees on format d.dd. Positive with port side up.
pitch	Pitch in degrees on format d.dd. Positive with bow up.
heave	Heave in metres on format d.dd. Positive down.
roll-rate	Roll rate in degrees per second on format d.dd. Positive when port side is moving upwards.
pitch-rate	Pitch rate in degrees per second on format d.dd. Positive when bow is moving upwards.
yaw-rate	Yaw rate in degrees per second on format d.dd. Positive when bow is moving towards starboard.

vertical-vel	Vertical velocity in metres per second on format d.dd. Positive when moving downwards.
event	Event code: 1 = system restart.
csum	Checksum (exclusive or) of all characters between, but not including, the preceding **$** and *****, hexadecimal (00 - FF).
term	CR-LF (2 bytes, values 13 and 10).

The ZDA, GGA, GLL, VTG, HDT, GST, GSA, GRS, PSXN 20, 21, 22 and 23 messages are output regularly at an adjustable rate. If gyro calibration data are not being calculated, the PSXN, 22 message is not output. The PSXN, 21 message is output once when an event occurs.

A sub set of the available NMEA messages can be configured individually for each serial line.

A.2 Binary format 3

This binary format consists of a fixed-length message using single-byte unsigned, 4-byte two-complement integer and 4-byte IEEE floating point data elements. For the multi-byte elements, the most significant byte is transmitted first.

Format:

Element	**Scaling**	**Format**	**Bytes**	**Value**
Header		ASCII	1	ASCII "q"
Length		Unsigned	1	49
Token		Unsigned	1	0 - 255
Time	nanoseconds	Integer	4	0 - 999999999
Latitude	2^{30} = 90 degrees	Integer	4	-2^{30} - 2^{30}
Longitude	2^{30} = 90 degrees	Integer	4	-2^{31} - 2^{31}
Height	metres	Float	4	
Heave	metres	Float	4	
North velocity	metres/second	Float	4	
East velocity	metres/second	Float	4	
Down velocity	metres/second	Float	4	
Roll	radians	Float	4	
Pitch	radians	Float	4	

Element	Scaling	Format	Bytes	Value
Heading	radians	Float	4	0 - 2 pi
Status word		Bit-fields	4	
Checksum		Unsigned	1	0 - 255

Length is number of bytes between, but not including, the Length and Checksum fields. Checksum is calculated modulo 256 of all bytes between, but not including, the Length and Checksum fields. The contents of the Token field is adjustable. Latitude is positive north of the Equator. Longitude is positive east of Greenwich. Height is above the ellipsoid. Heave is positive down. Roll is positive with port side up. Pitch is positive with bow up.

The status word consists of 32 single bit flags numbered from 0 to 31, where 0 is the least significant bit. A 1 value (true) means:

Bit no.	Interpretation
0	Reduced horizontal position and velocity performance.
1	Invalid horizontal position and velocity data.
2	Reduced heave and vertical velocity performance.
3	Invalid heave and vertical velocity data.
4	Reduced roll and pitch performance.
5	Invalid roll and pitch data.
6	Reduced heading performance.
7	Invalid heading data.

The remaining bits in the status word are reserved for future expansion.

A.3 Simrad EM3000 format 6

The Simrad EM3000 format consists of a fixed-length message using single-byte unsigned, 2-byte unsigned and 2-byte two-complement integer data elements. For the 2-byte elements, the least significant byte is transmitted first.

Format:

Element	Scaling	Format	Bytes	Value
Status byte		Unsigned	1	
Header		Unsigned	1	90 Hex

Element	Scaling	Format	Bytes	Value
Roll	0.01 degrees	Integer	2	-17999 to 17999
Pitch	0.01 degrees	Integer	2	-17999 to 17999
Heave	1 cm	Integer	2	-999 to 999
Heading	0.01 degrees	Unsigned	2	0 to 35999

Roll is positive with port side up. Pitch is positive with bow up. Heave is positive up.

The status byte can have the following values:

Value	Interpretation
90 Hex	Normal
91 Hex	Reduced performance
A0 Hex	Invalid data

Invalid data are also indicated by values outside the specified ranges. When the status is A0, the values which are within specified ranges can be assumed to have valid, but reduced quality.

A.4 Calibration format

The calibration format is a columnar ASCII text format for use when calibrating the GNSS antenna installation.

Format:

Element	Columns	Scaling	Decimals	Value
Time	1 - 7	seconds	1	0.0 - 86399.9
Heading	10 - 15	degrees	2	0.00 - 359.99
Gyro heading	18 - 23	degrees	2	0.00 - 359.99
Baseline	26 - 31	metres	3	
Height	34 - 38	metres	2	
Term	39 - 40			CR-LF

Each record consists of numbers on ASCII format separated by spaces and terminated by carriage return and linefeed (values 10 and 13). Leading spaces are used, so the numbers are separated by two or more spaces, and spaces may occur before the first number on the record.

Time is counted since last midnight UTC time. Heading is true heading from the GNSS phase measurement, which is not the same as the heading output on the other formats. Gyro heading is from an external gyro, 0.00 if no gyro is connected. Baseline is the slant range between the antenna centres from the GNSS phase measurement. Height is the height difference between the antennas from the GNSS phase measurement. Height is positive if antenna 1 is above antenna 2.

The data are intended for calibration of the antenna installation, so no data are output unless the GNSS phase measurements are valid.

A.5 Echo sounder format 9

This echo sounder format is a proprietary ASCII text format with fixed-length records used when connecting Simrad EA500 and other echo sounders.

Format:

Element	Columns	Scaling	Format
Header	1 – 7		:000000
Heave	9 – 13	1 cm	sdddd
Warning	14		space or “?”
Roll	15 – 19	0.01 degree	sdddd
Pitch	21 – 25	0.01 degree	sdddd
Term	26 – 27		CR-LF

Heave is positive up. Roll is positive with port side up. Pitch is positive with bow up.

The zeroes in the header occupy the columns used for acceleration when this fomat is output from other systems. Seapath does not output acceleration.

“s” is the sign character, space if positive and “-“ if negative. “dddd” is a decimal number with leading zeroes where appropriate. The warning charater is space if data are normal, “?” if data are invalid or of reduced quality.

Columns between elements are filled with spaces.

The definition of the attitude angles in this format is different from the Euler angles definition used elsewhere. The difference appears in the roll angle, where:

$$roll_{echo-sounder} = \arcsin\left[\sin(roll_{Euler}) \cdot \cos(pitch_{Euler})\right]$$

A.6 RDI ADCP format 10

The RDI format is a proprietary ASCII text format used when connecting RDI ADCP equipment.

Format: **$PRDID,***pitch***,***roll***,***head term*

Explanation:

pitch Pitch, degrees on format sddd.dd. s is the sign character, "+" or "-". ddd.dd is a decimal number with leading zeroes where appropriate. Positive with bow up.

roll Roll, degrees on format sddd.dd. s is the sign character, "+" or "-". ddd.dd is a decimal number with leading zeroes where appropriate. Positive with port side up.

head Heading, degrees true on format ddd.dd, with leading zeroes where appropriate.

term CR-LF (2 bytes, values 13 and 10).

A.7 Binary format 11

This binary format consists of a fixed-length message using 1-, 2- and 4-byte signal and unsigned integers. The signed integers are represented as two-complement numbers. For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 42.

Format:

Element	**Scaling**	**Format**	**Bytes**	**Value**
Header		ASCII	1	ASCII "q"
Time, seconds	seconds	Integer	4	
Time, fraction of second	0.01 second	Unsigned	1	0 - 99
Latitude	2^{30} = 90 degrees	Integer	4	-2^{30} - 2^{30}
Longitude	2^{30} = 90 degrees	Integer	4	-2^{31} - 2^{31}
Height	centimetres	Integer	4	
Heave	centimetres	Integer	2	
North velocity	centimetres/second	Integer	2	

Element	Scaling	Format	Bytes	Value
East velocity	centimetres/second	Integer	2	
Down velocity	centimetres/second	Integer	2	
Roll	2^{14} = 90 degrees	Integer	2	-2^{15} - 2^{15}
Pitch	2^{14} = 90 degrees	Integer	2	-2^{15} - 2^{15}
Heading	2^{14} = 90 degrees	Unsigned	2	0 - 2^{16}
Roll rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} - 2^{15}
Pitch rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} - 2^{15}
Yaw rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} - 2^{15}
Status word		Bit-fields	2	
Checksum		Unsigned	2	

Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds. Latitude is positive north of the Equator. Longitude is positive east of Greenwich. Height is above the ellipsoid. Heave is positive down. Roll is positive with port side up. Pitch is positive with bow up.

The status word consists of 16 single bit flags numbered from 0 to 15, where 0 is the least significant bit. A 1 value (true) means:

Bit no.	Interpretation
0	Reduced horizontal position and velocity performance.
1	Invalid horizontal position and velocity data.
2	Reduced heave and vertical velocity performance.
3	Invalid heave and vertical velocity data.
4	Reduced roll and pitch performance.
5	Invalid roll and pitch data.
6	Reduced heading performance.
7	Invalid heading data.

The remaining bits in the status word are reserved for future expansion.

A.8 Lehmkuhl gyro repeater format 12

This Lehmkuhl gyro repeater format is used when outputting heading from Seapath to Lehmkuhl gyro repeaters. The messag is similar to the HDT message output in the standard NMEA format from Seapath. The main differences are lower resolution and no checksum.

When heading is output to devices, which are compliant to the NMEA specification [1], it is recommended to use the standard NMEA format and not the Lehmkuhl format.

A.9 1PPS time tag, NMEA ZDA message

This 1PPS time tag message is output once per second, approximately 0.5 seconds before the time pulse. The message format is ASCII text using the ZDA message defined in [1]. The message contains the UTC time when the message is output. The next time pulse appears at the first integer second after the time in the message.

Format: **$INZDA,***time***,***day***,***month***,***year***,,*****csum** *term*

Explanation:

time	UTC time on format hhmmss.ss where hh is hours (00 - 23), mm is minutes (00 - 59) and ss.ss is seconds (00.00 - 59.99).
day	Day of month (01 - 31).
month	Month of year (01 - 12).
year	Year on format yyyy.
csum	Checksum (exclusive or) of all characters between, but not including, the preceding **$** and *****, hexadecimal (00 - FF).
term	CR-LF (two bytes, values 13 and 10).

This format is recommended used together with 1PPS signal output on the BNC connector at the rear of the Processing Unit. This since the message is output synchronised with the 1PPS signal and is easier/faster to decode than the standard NMEA output with a number of NMEA messages included.

A.10 1PPS time tag, Trimble compatible

This 1PPS time tag message is output once per second, approximately 0.5 seconds before the time pulse. The message format is fixed length ASCII text. The message contains the UTC time of the next time pulse.

Format:

Element	Columns	Format
Header	1 - 3	UTC
Date	5 - 12	yy.mo.da
Time	14 - 21	hh:mm:ss
Fix type	23	digit or '?'
No. of satellites	24	digit or '?'
Term	25 - 26	CR-LF

“yy.mo.da” is year (00 - 99), month of year (01 - 12) and day of month (01 - 31). “hh:mm:ss” is hours (00 - 23), minutes (00 - 59) and seconds (00 - 59). Fix type is “5” for 3D fix with accurate time, “?” for no fix (time from receiver clock). No. of satellites is “1” – “8” for 1 - 8 satellites tracked, “9” for 9 or more satellites tracked, “?” for no fix (time from receiver clock).

Columns between elements are filled with spaces.

A.11 Atlas Fansweep format 16

This Atlas format is a proprietary binary format used for outputting data to Atlas Fansweep echo sounders. It consists of a fixed-length message using single-byte and 2-byte two-complement integer data elements. For the 2-byte elements, most significant byte is transmitted first.

Format:

Element	Scaling	Format	Bytes	Value
Start byte		Integer	1	10 Hex
Roll	2^{14} = 90 degrees	Integer	2	
Pitch	2^{14} = 90 degrees	Integer	2	
Heave	millimetres	Integer	2	
Status byte		Integer	1	
Stop byte		Integer	1	10 Hex

Roll is positive with port side up. Pitch is positive with bow up. Heave is positive up.

The definition of the attitude angles in this format is different from the Euler angles definition used elsewhere. The difference appears in the roll angle, where:

$$roll_{Atlas} = \arcsin\left[\sin(roll_{Euler}) \cdot \cos(pitch_{Euler})\right]$$

The status byte can have the following values:

Value	Interpretation
6	Normal.
7	Reduced performance or invalid data.

A.12 Echo sounder format 18, TSS1

This echo sounder format is a proprietary ASCII text format with fixed-length records used when connecting Seapath to Seabeam and other echo sounders.

Format:

Element	Columns	Scaling	Format
Header	1 - 7		:000000
Heave	9 - 13	1 cm	sdddd
Warning	14		"F" or "f"
Roll	15 - 19	0.01 degree	sdddd
Pitch	21 - 25	0.01 degree	sdddd
Term	26 - 27		CR-LF

Heave is positive up. Roll is positive with port side up. Pitch is positive with bow up.

The zeroes in the header occupy the columns used for acceleration when this format is output from other systems. Seapath does not output acceleration.

“s” is the sign character, space if positive and “-“ if negative. “dddd” is a decimal number with leading zeroes where appropriate. The warning character is “F” if data are normal, “f” if data are invalid or of reduced quality.

Columns between elements are filled with spaces.

The definition of the attitude angles in this format is different from the Euler angles definition used elsewhere. The difference appears in the roll angle, where:

$$roll_{echo-sounder} = \arcsin\left[\sin(roll_{Euler}) \cdot \cos(pitch_{Euler})\right]$$

A.13 Binary format 23

This binary format consists of a fixed-length message using 1-, 2- and 4-byte signed and unsigned integers. The signed integers are represented as two-complement numbers. For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 44.

Format:

Element	**Scaling**	**Format**	**Bytes**	**Value**
Header		Unsigned	1	AA Hex
Header		Unsigned	1	51 Hex
Time, seconds	Seconds	Integer	4	
Time, fraction of second	0.0001 second	Unsigned	2	0 to 9999
Latitude	2^{30} = 90 degrees	Integer	4	-2^{30} to 2^{30}
Longitude	2^{30} = 90 degrees	Integer	4	-2^{31} to 2^{31}
Height	Centimetres	Integer	4	
Heave	Centimetres	Integer	2	
North velocity	Centimetres/second	Integer	2	
East velocity	Centimetres/second	Integer	2	
Down velocity	Centimetres/second	Integer	2	
Roll	2^{14} = 90 degrees	Integer	2	-2^{15} to 2^{15}
Pitch	2^{14} = 90 degrees	Integer	2	-2^{15} to 2^{15}
Heading	2^{14} = 90 degrees	Unsigned	2	0 to 2^{16}
Roll rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} to 2^{15}
Pitch rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} to 2^{15}
Yaw rate	2^{14} = 90 degrees/second	Integer	2	-2^{15} to 2^{15}
Status word		Bit-fields	2	
Checksum		Unsigned	2	

Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds. Latitude is positive north of the Equator. Longitude is positive east of Greenwich. Height is above the ellipsoid. Heave is positive down. Roll is positive with port side up. Pitch is positive with bow up.

The status word consists of 16 single bit flags numbered from 0 to 15, where 0 is the least significant bit. A 1 value (true) means:

Bit no.	**Interpretation**
0	Reduced horizontal position and velocity performance
1	Invalid horizontal position and velocity data
2	Reduced heave and vertical velocity performance
3	Invalid heave and vertical velocity data
4	Reduced roll and pitch performance
5	Invalid roll and pitch data
6	Reduced heading performance
7	Invalid heading data

The remaining bits in the status word are reserved for future expansion.

A.14 PFreeHeave format 24

This PFreeHeave™ format consists of a fixed-length message using 1-, 2- and 4-byte signed and unsigned integers. The signed integers are represented as two-complement numbers. For the multi-byte elements, the most significant byte is transmitted first. The total number of bytes is 13.

The PFreeHeave output is delayed by a few minutes due to processing. The time fields contain time of validity for the data.

Format:

Element	**Scaling**	**Format**	**Bytes**	**Value**
Header		Unsigned	1	AA Hex
Header		Unsigned	1	52 Hex
Time, seconds	Seconds	Integer	4	
Time, fraction of second	0.0001 second	Unsigned	2	0 to 9999
Heave	Centimetres	Integer	2	

Element	Scaling	Format	Bytes	Value
Status word		Bit-fields	1	
Checksum		Unsigned	2	

Checksum is calculated as a 16-bit Block Cyclic Redundancy Check of all bytes between, but not including the Header and Checksum fields. The CRC algorithm is described in a separate section. Time is divided in an integer seconds part and a fractional second part. The integer seconds part of time is counted from 1970-01-01 UTC time, ignoring leap seconds. Heave is positive down. The status field is zero if heave is valid, non-zero if heave is invalid.

A.15 Cyclic redundancy check algorithm

The 16-bit Block Cyclic Redundancy Check algorithm used to calculate the checksum in some formats is described in C and Fortran source code below.

C code:

```
#define POLY 0x8408
unsigned short blkcrc(
   unsigned char *bufptr,       /* message buffer */
   unsigned long len            /* number of bytes */
   )
{
   unsigned char i;
   unsigned short data;
   unsigned short crc = 0xffff;

   if (len == 0L) {
      return ~crc;
   }

 do {
      for (i=0, data = (unsigned short) (0xff & *bufptr++);
           i < 8;
           i++, data >>= 1) {
         if ((crc & 0x0001) ^ (data & 0x0001)) {
            crc = (crc >> 1) ^ POLY;
         } else {
            crc >>= 1;
         }
      }
   } while (--len);
```

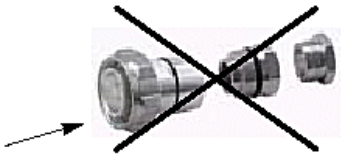
```
   crc = ~crc;
   data = crc;
   crc = (crc << 8) | ((data >> 8) & 0xff);

   return crc;
}
```

Fortran code:

```
      SUBROUTINE blkcrc(inbuffer, len, crc)

      INTEGER*2 len, i , bit
      INTEGER*4 crc, data, poly
      CHARACTER inbuffer*(*)

      poly = 16#8408
      crc  = 16#FFFF
      data = 0

      IF (len.EQ.0) THEN
          crc = 0
          RETURN
      END IF

      DO i = 1, len
          data = ICHAR(inbuffer(i:i))
          DO bit = 1, 8
              data = IAND(data,16#FF)
              IF (IAND(crc,16#01).EQ.(IAND(data,16#01))) THEN
                  crc = ISHL(crc,-1)
              ELSE
                  crc = ISHL(crc,-1)
                  crc = IEOR(crc, poly)
              END IF
              data = ISHL(data,-1)
          END DO
      END DO

      data = IEOR(crc,16#FFFF)
      crc = IOR(ISHL(data,8),IAND(ISHL(data,-8),16#FF))

      END
```

APPENDIX B INSTALLATION OF COAX CONNECTORS ON SUPERFLEX CABLE

The connector consists of two parts: the connector head and the cable entry.



Do not open!
Bitte nicht öffnen!
No abrir por favor!

mit / with / con

Required Tools: Stripping Tool 74 Z-0-9-15 (see also 27345), Spanners AF 21 and 22 mm, Metal Saw, Knife, Abrasive Paper 320.

Benötigte Hilfsmittel: *Abisolierwerkzeug 74 Z-0-9-15 (siehe auch 27345), Gabelschlüssel 21 und 22 mm, Metall-Säge, Messer, Schleifpapier 320.*

Herramientas requeridas: Fresador especial 74 Z-0-9-15 véanse también 27345) , llaves de horquilla de 21 y 22 mm, sierra para metal, cuchilla, papel de lija 320.

ohne / without / sin

Required Tools: Spanners AF 21 and 22 mm, Metal Saw, Knife, Measure, Abrasive Paper 320, File.

Benötigte Hilfsmittel: *Gabelschlüssel 21 und 22 mm, Metall Säge, Messer, Massstab, Schleifpapier, Feile.*

Herramientas requeridas: Llaves de horquilla de 21 y 22 mm, sierra para metal, cuchilla, regla graduada, papel de lija 320, lima.

with / mit / con

Cut the cable off square (perpendicular to the cable axis).

1. *Das Kabel rechtwinklig absägen.*

Cortar el cable en ángulo recto.

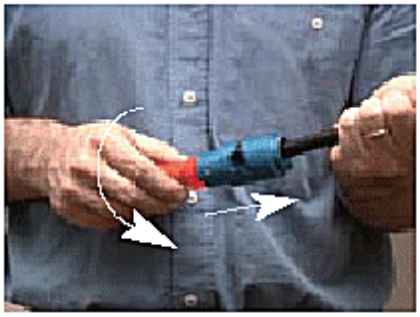
without / *ohne* / sin

⇒ **see page/ *siehe Seite* /véase página 4**

Strip the cable with the stripping tool 74 Z-0-9-15 as far as the stop.

2. *Kabel mit Abisolierwerkzeug 74 Z-0-9-15 bis zum Anschlag abisolieren.*

Aislar el cable con el fresador 74 Z-0-9-15 hasta el tope.



Deburr outer conductor carefully.

3. *Aussenleiter sorgfältig entgraten.*

Eliminar cuidadosamente las asperezas del conductor exterior.

IMPORTANT! **WICHTIG!** **IMPORTANTE!**

DAMAGED THREAD!
BESCHÄDIGTES GEWINDE!
ROSCA ESTROPEZADA!

GOOD!
RICHTIG!
CORRECTO!

Clean the centre conductor carefully with abrasive paper.

4. *Innenleiter mit Schleifpapier gut reinigen.*

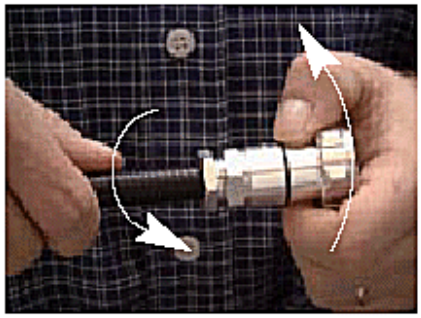
Limpiar cuidadosamente el conductor interior con el papel de lija.

with / mit / con

Screw the connector on the cable as far as the stop.

5. *Verbinder bis zum Anschlag auf das Kabel schrauben.*

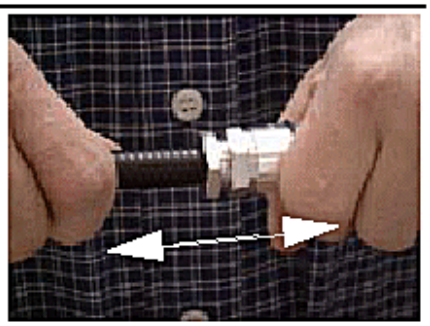
Atornillar el conector en el cable hasta el tope.



Check connector seat by pulling the cable which should not be pulled out of the connector.

6. *Zur Kontrolle am Kabel ziehen; dabei darf sich das Kabel nicht herausziehen lassen.*

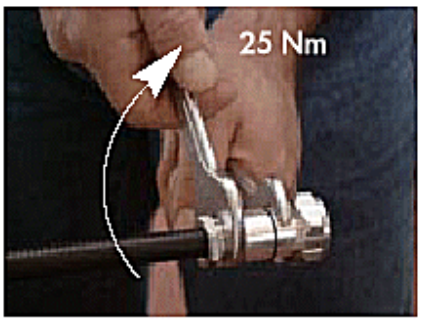
Controlar si el cable está fijo, tirandolo. Este no debe salir del conector.



Tighten connector head and cable entry with approx. 25 Nm. **Rotate the cable entry only.**

7. *Verbinderkopf und Kabeleinführung mit ca. 25 Nm zusammenschrauben.* ***Nur die Kabeleinführung drehen.***

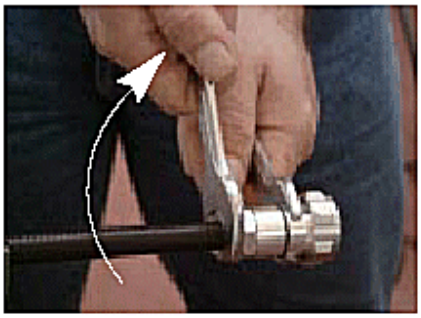
Montar la cabeza del conector y la entrada del cable con aproximadamente 25 Nm **girando la guía del cable.**



Tighten the back nut of the cable entry as far as the stop.

8. *Die hintere Mutter der Kabeleinführung bis zum Anschlag anziehen.*

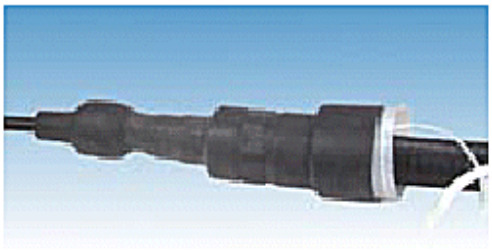
Apretar la tuerca posterior de la guía del cable hasta el tope.



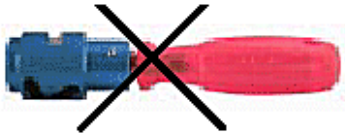
Optional: Cover the mated connector pair with a cold shrink sleeve (e.g. 74 Z-0-0-337).

9. ***Optional:*** *Verbinderpaar mit Kaltschrumpfschlauch (z.B. 74 Z-0-0-337) zusätzlich abdichten.*

Opcional: Proteger el conector utilizando un tubo exterior colocado en frío (p.ej. 74 Z-0-0-337).



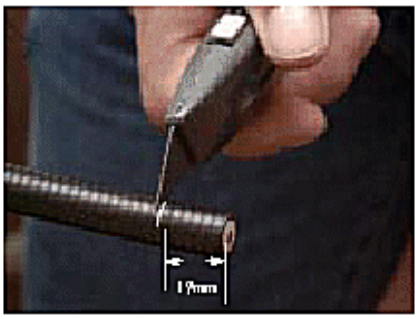
without / ohne / sin



Cut back the cable jacket about 19 mm (*0.75 in.*).

2. *Kabelmantel 19 mm zurückschneiden.*

Cortar y separar 19 mm del revestimiento exterior.



Cut back the outer conductor 8 mm (*0.31 in.*) **Do not damage the centre conductor.**

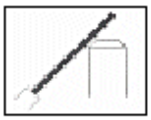
3. *Aussenleiter 8 mm zurückschneiden.* ***Innenleiter darf nicht beschädigt werden.***

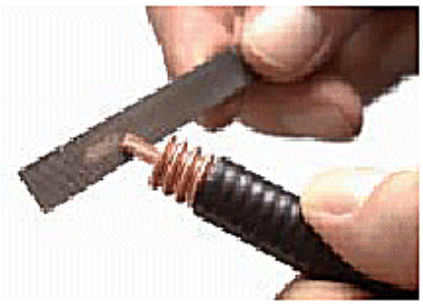
Cortar 8 mm del conductor exterior. **No dañar el conductor interior!**

Chamfer centre conductor.

4. *Innenleiter anfasen.*

Dar forma cónica al conductor interior.





Follow with step 3 on page 2

5. ***Fahren Sie mit Schritt 3, Seite 2 weiter***

Continue con paso no. 3, página 2

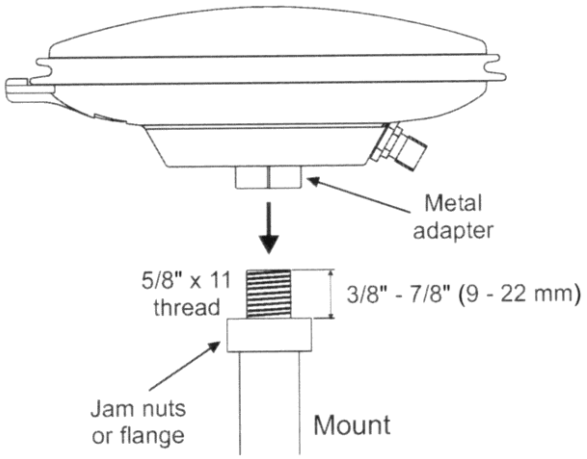
APPENDIX C GNSS ANTENNA INSTALLATION

Installing the antenna

After a site has been selected, install the antenna as follows.

1. Verify that the thread on the mount does not extend more than 7/8" (22 mm) to ensure the plastic inside the antenna receptacle is not damaged when the mount is inserted. If it extends further than 7/8" (22 mm), add two jam nuts to shorten the exposed thread, ensuring the nuts are well-tightened.

2. Align the mount thread with the metal adapter on the bottom of the antenna and rotate the antenna clockwise until it is securely screwed to the mount. Using a wrench, tighten the adapter to the mount.

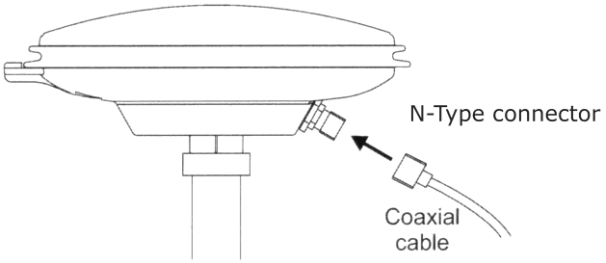


3. Remove the dust cap from the antenna's N-Type connector.

4. Attach the male N-Type connector of the coaxial cable to the antenna's N-Type.

✉ The metal adapter on the bottom of the antenna is fixed in place. Do not attempt to remove it.

5. Attach the end of the coaxial cable to the antenna input port of the receiving device. All NovAtel GNSS receivers provide the necessary power through their antenna RF connectors.



Antenna care

The GPS-702-GG-N is designed to withstand the elements, including rain, snow and dust. However, to ensure your antenna performs optimally, keep the radome (top surface of the antenna) clean and brush off any ice and snow. In addition, ensure the N-Type connector remains clean and dry and replace the dust cap when a cable is not connected.

Excerpt from GPS-702-GG, GPS-701-GG and GPS702-GG-N User Guide, OM-20000095, rev. 1B, August 7, 2009, NovAtel Inc.

APPENDIX D ½" COAX CABLE SPECIFICATION

SCF12-50 Series
1/2" Superflexible Foam Coax

APPLICATIONS	
OEM jumpers, Main feed transitions to equipment, GPS lines, Riser-rated In-Building (JFN types, only)	
GENERAL INFORMATION	
Cable Type	Foam-Dielectric, Superflexible
Size	1/2"
STRUCTURE	
Inner Conductor Material	Copper-Clad Aluminum Wire
Diameter Inner Conductor, mm (in)	3.6 (0.14)
Diameter Dielectric, mm (in)	8.3 (0.33)
Outer Conductor Material	Corrugated Copper
Diameter Copper Outer Conductor, mm (in)	12.3 (0.48)
Diameter over Jacket Nominal, mm (in)	13.7 (0.54)
MECHANICAL SPECIFICATIONS	
Cable Weight, kg/m (lb/ft)	0.21 (0.14)
Minimum Bending Radius, Repeated Bends, mm (in)	32 (1.25)
Bending Moment, N•m (lb-ft)	1.8 (1.3)
Flat Plate Crush Strength, N/mm (lb/in)	20.4 (110)
Tensile Strength, N (lb)	650 (146)
Recommended / Maximum Clamp Spacing, m (ft)	0.30 / 0.30 (1.00 / 1.00)
ELECTRICAL SPECIFICATIONS	
Impedance, Ohm	50 +/- 1
Velocity, percent	82
Capacitance, pF/m (pF/ft)	82.0 (25.0)
Inductance, µH/m (µH/ft)	0.207 (0.063)
Maximum Frequency, GHz	11.7
Peak Power Rating, kW	20.5
RF Peak Voltage, Volts	1430
Jacket Spark, Volt RMS	5000
Inner Conductor dc Resistance, ohm/1000 m (ohm/1000 ft)	2.9 (0.88)
Outer Conductor dc Resistance, ohm/1000 m (Ohm/1000 ft)	3.4 (1.04)

See Installation, Operation and Storage Temperatures on page 28.
For premium return loss codes see page 29.

CONNECTORS AND ACCESSORIES	
Connectors	See pages 70-77
Jumpers	See pages 82-87
Accessories	See pages 97-102
Coaxial Devices	See pages 106-108
Technical Appendix	See pages 639-648

SCF12-50J/JFN ATTENUATION AND AVERAGE POWER

Frequency MHz	Attenuation dB/100 m	Attenuation dB/100 ft	Average Power kW
0.5	0.229	0.0697	20.5
1.0	0.324	0.0986	20.5
1.5	0.397	0.121	20.5
2.0	0.458	0.140	18.8
10	1.03	0.314	8.37
20	1.46	0.446	5.90
30	1.80	0.548	4.80
50	2.33	0.710	3.70
88	3.11	0.949	2.77
100	3.33	1.01	2.59
108	3.46	1.06	2.49
150	4.10	1.25	2.10
174	4.43	1.35	1.95
200	4.76	1.45	1.81
300	5.89	1.79	1.46
400	6.85	2.09	1.26
450	7.29	2.22	1.18
500	7.71	2.35	1.12
512	7.81	2.38	1.10
600	8.50	2.59	1.01
700	9.23	2.81	0.934
800	9.92	3.02	0.869
824	10.1	3.07	0.855
894	10.5	3.21	0.818
900	10.6	3.22	0.815
925	10.7	3.27	0.803
960	11.0	3.34	0.787
1000	11.2	3.41	0.770
1250	12.7	3.86	0.682
1500	14.0	4.26	0.616
1700	15.0	4.57	0.575
1800	15.5	4.72	0.557
2000	16.4	5.01	0.525
2100	16.9	5.15	0.511
2200	17.3	5.28	0.498
2400	18.2	5.55	0.474
3000	20.7	6.30	0.417
3500	22.6	6.88	0.382
4000	24.4	7.4	0.353
5000	27.8	8.5	0.310
6000	31.0	9.4	0.278
7000	34.0	10.4	0.254
8000	36.8	11.2	0.234
9000	39.6	12.1	0.218
10000	42.3	12.9	0.204
11700	46.6	14.2	0.185

Standard Conditions:
For attenuation: VSWR 1.0, cable temperature 20° C (68° F).
For average power: VSWR 1.0, ambient temperature 40° C (104°F), inner conductor temperature 100° C (212° F). No solar loading.

APPENDIX E RG-214 SPECIFICATIONS

HUBER+SUHNER® DATA SHEET
Coaxial Cable: RG_214_HIFLEX

Rev.: O.00

Description

PE-50 Ohm - double screen

Technical Data

Construction

	Material	Detail	Diameter	
Centre conductor	Copper, Silver plated	Strand-19	2.25	mm
Dielectric	POE (Polyolefine Elastomer)		7.3	mm
Outer conductor	Copper, Silver plated	Braid, 93 %	8	mm
Outer conductor	Copper, Silver plated	Braid, 95 %	8.7	mm
Jacket	PVC II (non migration)	RAL 9005 - bk	10.8	mm +/- 0.15
Print	HUBER+SUHNER RG 214 HiFlex 50 Ohm (PA no.)			

Electrical Data

Impedance	50	Ω +/- 2
Max. operating frequency	6	GHz
Capacitance	101	pF/m
Velocity of signal propagation	66	%
Signal delay	5.03	ns/m
Insulation resistance	≥1 x	10^6 MΩm
Min. screening effectiveness	>70	dB (up to 1 GHz)
Max. operating voltage	5	kV_{rms} (at sea level)
Test voltage	10	kV_{rms} (50 Hz/1 min)

Mechanical Data

Weight		18.5	kg/100 m
Min. bending radius	static	15	mm
	repeated (for max. 50 bendings)	60	mm
	dynamic	100	mm

Environmental Data

Temperature range		-25 °C... + 85 °C
Installation temperature	-20 °C... + 60 °C	
Flammability	IEC 60332-1	
2002/95/EC (RoHS)	compliant	

Ordering Information

Order as	RG_214_HIFLEX

Additional Information

Remarks

(For details refer to the HUBER+SUHNER RF CABLES GENERAL CATALOGUE or contact your nearest HUBER+SUHNER partner)

Suitable Connectors

Cable group	crimped (U32)
	clamped (U33)
	soldered —

HUBER+SUHNER® DATA SHEET
Coaxial Cable: RG_214_HIFLEX

Rev.: O.00

Matrix **Attenuation** [formula: (a*f^0.5 + b*f)] **and Power CW** [formula: (p*/ f^0.5)]

Coefficients:

a=	0.1924	b=	0.0567	$f_{max.}$=	6	$p_{at\ 1GHz}$ =	320
	Frequency		**Nom. attenuation**		**Nom. attenuation**		**Max. CW power**
	(GHz)		**(dB / m)**		**(dB / ft)**		**(watt)**
			sea level 25° C ambient temperature		sea level 25° C ambient temperature		sea level 40° C ambient temperature
	0.3		0.12		0.037		584
	0.6		0.18		0.055		413
	0.9		0.23		0.070		337
	1.2		0.28		0.085		292
	1.5		0.32		0.098		261
	1.8		0.36		0.110		239
	2.1		0.40		0.122		221
	2.4		0.43		0.131		207
	2.7		0.47		0.143		195
	3.0		0.50		0.152		185
	3.3		0.54		0.165		176
	3.6		0.57		0.174		169
	3.9		0.60		0.183		162
	4.2		0.63		0.192		156
	4.5		0.66		0.201		151
	4.8		0.69		0.210		146
	5.1		0.72		0.219		142
	5.4		0.75		0.229		138
	5.7		0.78		0.238		134
	6.0		0.81		0.247		131

HUBER+SUHNER is certified according to ISO 9001 and ISO 14001

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APPENDIX F SERIAL PORT EXTENDER

The serial port extender (part no G071-97) can be delivered as an option for connection to the Processing Unit. The extender is a 8-port RS-232/422/485 serial device server, type Moxa NPort 5650I-8-DT.

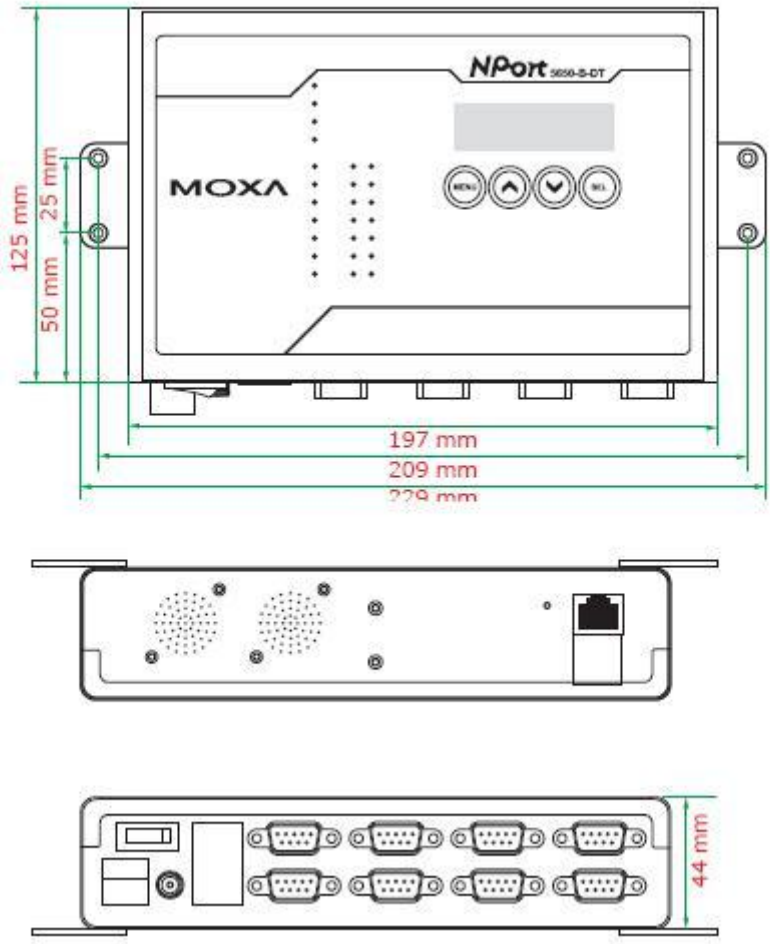

Figure 60 Serial port extender with 8-ports

F.1 Mechanical installation

Mounting accessories are available for installing the serial port extender, the optional power supply and the optional Ethernet switch on a DIN rail. Alternatively, the serial port extender can be installed on a panel.

F.2 Electrical installation

Connect the serial port extender to the network used for communication between LAN 2 on the Processing Unit and LAN on the HMI Unit. The 5650I-8-DT has an internal Ethernet switch with two external ports, which is sufficient for a network containing only these three devices.

Connect 24 V DC power to the serial port extender. Connect power to the Ethernet switch if applicable.

F.3 Configuration

Choose a free IP address on the network for the serial port extender.

On the front panel, select **Main Menu** | **Network setting** | **IP address** and enter the chosen IP address. Select **Main Menu** | **Network setting** | **Netmask** and change the subnet mask if necessary. Select **Main Menu** | **Save/Restart**.

Open the chosen IP address in a web browser. (The web browser must accept cookies.) Select **Main Menu** | **Serial settings**. Set **Flow control** to **None** for all ports. Set **Interface** to **RS-422** or **RS-232** for each port to match the connected equipment. No other configuration changes should be made in the web browser. Submit and activate the configuration.

In NavEngine advanced configuration, select **Root** | **Communication** | **SerialPortExtender**. Set **IpAddress** to the chosen IP address. Set **NoPorts** to the number of serial ports connected (8). Set **Type** to 1. Restart the Processing Unit.

After restart, the serial ports are available in the NavEngine communications configuration. Change of interface type between RS-422 and RS-232 must be made from the web browser.

Note *The extended serial ports are not as accurate with regard to timing as Com 9 to 14 and are not recommended used for timing critical outputs.*

APPENDIX G FREE AND OPEN SOURCE SOFTWARE

Some of the software components in this product are free and open source software released under the licenses shown below. Source code for the relevant software components is available from:

Kongsberg Seatex AS

Attn.: Customer support

Pirsenteret

N-7462 Trondheim

Norway

E-mail km.support.seatex@kongsberg.com

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Version 2, June 1991

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G.8 Ubuntu licensing

Ubuntu is a collection of many computer programmes and documents created by thousands of individuals, teams and companies. Each of these works may come under a different license. This license policy describes the process that we follow in determining which software we will ship by default on the Ubuntu Desktop CD.

Categories of software in Ubuntu

The thousands of software packages available for Ubuntu are organised into three key components: main, restricted and universe. Software is published in one of those components based on whether or not it meets our Free Software Philosophy, and the level of support we can provide for it.

You can read about these components in more detail http://www.ubuntu.com/community/ubuntustory/components. This policy only addresses the software that you will find in main and restricted, which contain software that is fully supported by the Ubuntu team and must comply with this policy.

In the universe component you will find just about every other piece of software you can imagine, under a huge variety of licenses... really the full software universe. If you install software from universe please ensure you take the time to check the license for yourself.

All software in Ubuntu main and restricted must be licensed in a way that is compatible with our license policy. There are many definitions of 'free' and 'free software' so we have included our own set of guidelines.

Ubuntu "main" Component license Policy

All application software included in the Ubuntu main component:

- Must include source code. The main component has a strict and non-negotiable requirement that application software included in it must come with full source code.
- Must allow modification and distribution of modified copies under the same license. Just having the source code does not convey the same freedom as having the right to change it. Without the ability to modify software, the Ubuntu community cannot support software, fix bugs, translate it, or improve it.

Ubuntu "main" and "restricted" Component license Policy

All application software in both main and restricted must meet the following requirements:

- Must allow redistribution. Your right to sell or give away the software alone, or as part of an aggregate software distribution, is important because:
- You, the user, must be able to pass on any software you have received from Ubuntu in either source code or compiled form.
- While Ubuntu will not charge license fees for this distribution, you might well want to charge to print Ubuntu CD's, or create your own customized versions of Ubuntu which you sell, and should have the freedom to do so.
- Must not require royalty payments or any other fee for redistribution or modification. It's important that you can exercise your rights to this software without having to pay for the privilege, and that you can pass these rights on to other people on exactly the same basis.
- Must allow these rights to be passed on along with the software. You should be able to have exactly the same rights to the software as we do.
- Must not discriminate against persons, groups or against fields of endeavour. The license of software included in Ubuntu can not discriminate against anyone or any group of users and cannot restrict users from using the software for a particular field of endeavour - a business for example. Thus we will not distribute software that is licensed "freely for non-commercial use".
- Must not be distributed under a license specific to Ubuntu. The rights attached to the software must not depend on the programme's being part of Ubuntu system. So we will not distribute software for which Ubuntu has a "special" exemption or right, and we will not put our own software into Ubuntu and then refuse you the right to pass it on.
- Must not contaminate other software licenses. The license must not place restrictions on other software that is distributed along with it. For example, the license must not insist that all other programmes distributed on the same medium be free software.
- May require source modifications to be distributed as patches. In some cases, software authors are happy for us to distribute their software and modifications to their software, as long as the two are distributed separately, so that people always have a copy of their pristine code. We are happy to respect this preference. However, the license must explicitly permit distribution of software built from modified source code.

Documentation, Firmware, and Drivers

Ubuntu contains licensed and copyrighted works that are not application software. For example, the default Ubuntu installation includes documentation, images, sounds, video clips and firmware. The Ubuntu community will make decisions on the inclusion of these works on a case-by-case basis, ensuring that these works do not restrict our ability to make Ubuntu available free of charge, and that Ubuntu remains re-distributable by you.

The purpose of the "restricted" component

The Ubuntu team recognises that many users have vital hardware in their computer that requires drivers that are currently only available in binary format. We urge all hardware vendors to insist that their suppliers provide open source drivers for their components, but we recognise that in some cases binary drivers are the only way to make your hardware work. As a result, Ubuntu includes several of these drivers on the CD and in the repository, clearly separated from the rest of the software by being placed in the restricted component.

Binary drivers are a poor choice, if you have a choice. Without source code, Ubuntu cannot support this software, we only provide it for users who require it to be able to run the Free Software we provide in main. Also, we cannot make binary drivers available on other architectures (such as the Mac or IPAQ) if we don't have the ability to port the software source code ourselves. If your hardware is fully supported with open source drivers you can simply remove the restricted component, and we would encourage you to do so.

Software installed by default

When you install Ubuntu, you will typically install a complete desktop environment. It is also possible to install a minimal set of software (just enough to boot your machine) and then manually select the precise software applications to install. Such a "custom" install is usually favoured by server administrators, who prefer to keep only the software they absolutely need on the server.

All of the application software installed by default is Free Software. In addition, we install some hardware drivers that are available only in binary format, but such packages are clearly marked in the restricted component.

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